DECEMBER 30, 2005 ★ VOLUME 56 ★ NUMBERS 27–37 & INDEX

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

(Fourth Series)

CALIFORNIA
ACADEMY OF SCIENCES
FOUNDED 1853

SAN FRANCISCO, CALIFORNIA

Scientific Publications

Cover image

From 1853 to 1906, when the Academy suffered the grievious loss of its handsome museum buildings as a result of the devastating earthquake and subsequent fire that swept San Francisco's downtown area, the Academy had been served by a number of exceptional persons as President of the fledgling organization. Each had distinguished himself as a scientist, mathematician, engineer, or in business, and most held administrative positions outside of the Academy. (Top row, left to right) Andrew Randall (1853–1856) had served as an assistant to Federal geologist David Dale Owen in the survey of the Wisconsin-Minnesota territories before coming to California, to Monterey; he was elected to the California State Legislature. Leander Ransom (missing portrait; 1856–1866) after a successful career as surveyor in Toledo, Ohio, came to California. He served as U.S. General Land Office deputy surveyor for Northern California, reporting to Samuel King, U.S. Surveyor General for California. Ransom wisely selected the summit of Mount Diablo as the initial point for a survey and then, during the hot summer of 1851, he laid out the meridian and baseline markers needed to initiate the triangulation survey of all of central California and western Nevada. Josiah Dwight Whitney (1867–1868) served for nearly a decade as head of the first official California Geological Survey. Earlier, he had done seminal work on the mineral wealth of the United States. In 1868 he left California for Harvard University. James Blake, M.D. (1869–1871) was a maverick naturalist, distingusihed scientist, and M.D. Blake had accompanied Howard Stansbury on the 1849–50 exploration of the Great Salt Lake before coming to California where he established a medical practice first in Sacramento and then San Francisco. He was responsible for having introduced new procedures for fermentation to California's wine industry, transforming it from producing undistuinguished wines to one that could compete with the best of Europe. (Second row, left to right) George Davidson (1872–1886), mathematician, was Chief of the Pacific Coast branch of the U.S. Coastal Survey, forerunner of the U.S. Coast and Geodetic Survey. Harvey Harkness (1898–1895) , physician and surgeon, wrote extensively about fungi. David Starr Jordan (1896–1897, 1900–1902, 1909–1911), distinguished ichthyologist and first President of Stanford University. (Third row, left to right) William Ritter (1898–1899), University of California, invertebrate zoologist. William Alvord (1903–1904), though not a scientist, he had an long-standing interest in both science and art. A successful business entrepreneur, he served a term as mayor of San Francisco, served on the Board of Directors of the Bank of California, and on numerous city commissions. Eusebius Molera (1905–1908), San Francisco engineer with an abiding interst in Aztec history, also served as President *Pro tem* of the Academy's Board of Trustees.

ISSN 0068–547X

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Published by the California Academy of Sciences
875 Howard Street, San Francisco, California 94103 U.S.A.

Printed in the United States of America by
Allen Press Inc., Lawrence, Kansas 66044

PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 27, pp. 395–525 December 30, 2005

A Checklist and Preliminary Bibliography of the Recent, Freshwater Diatoms of Inland Environments of the Continental United States

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This publication is dedicated to Dr. Eugene F. Stoermer on the occasion of his retirement.

A checklist of freshwater diatoms of inland environments of the continental United States is compiled. It includes over 4500 names across almost 170 genera. The genus *Navicula* has the greatest number of taxa recorded, followed by *Pinnularia*, *Nitzschia*, *Gomphonema*, and *Eunotia*. A preliminary bibliography of reports of diatoms from U.S. inland environments is also presented. The number of bibliographic entries is over 1,200, and includes reports from diverse publications. It is hoped that the checklist and bibliography can be used to develop a comprehensive diatom flora of the United States.

A challenge to documenting the Recent freshwater diatom flora of the United States is the lack of a synthesis of basic information. An understanding of the U.S. flora is important not only to assess the current state of our natural resources (in terms of biodiversity and subsequent changes due to changes in the physical, chemical and/or biological environment) but also to better understand the patterns of distribution within and outside the U.S.

Kociolek (submitted) has developed a list of taxa described from U.S. inland waters, and a comprehensive evaluation of all diatom names at the taxonomic level of species and below is forthcoming (Fourtanier & Kociolek, based on the approach for genus names developed by Fourtanier & Kociolek 1999, 2003). In addition to knowing what species have been described from the U.S., and the nomenclatural status of names, a third leg of the stool to begin a large-scale flora is a basic checklist of previously reported taxa. While many local and regional floras have been published (see Kociolek & Spaulding 2003 for a review of many of these), no comprehensive list of diatoms from the U.S. has been attempted in over 70 years (Boyer 1927a, b).

To develop a checklist for a region the size of the continental United States, a huge number of references had to be reviewed. A task such as this is daunting given the breadth of publications on U.S. diatoms reports that have been recorded. It was decided to develop in concert with the checklist, a bibliography of the references consulted, and to include them with the taxon compilation.

This current attempt could not be exhaustive, nor could it reconcile many of the discrepancies that are inherent in a preliminary checklist. It is hoped this listing provides a stepping stone forward to the development of a more accurate and, eventually, comprehensive understanding of the diatoms of inland environments of the United States.

METHODS

The listing of diatom names was derived from those reports of inland habitats in the United States. Names are recorded where names were full (at least genus and species) and accepted by the author. Names with question marks next to them or designated with a single letter or number have not been included. A reference citing each taxon in the list is provided; a complete set of references for each name was not attempted.

This listing of names reported in the literature, without original or cited interpretations means that there are redundancies in the names, either through taxonomic or nomenclatural synonymies. By nomenclatural (homotypic) synonymies, I mean there are different entries (names) based on a single type. Many of these occur in *Fragilaria, Synedra, Achnanthes, Brachysira, Anomoeoneis, Navicula* and others where there has been tremendous flux in the generic assignment of taxa. Despite the instability there has been in these names, much of this is well-known to those interested in diatom taxonomy, and they are more easily traced due to the way authors are listed after the taxon names in botanical nomenclature. Taxonomic (heterotypic) synonymies, where more than one name, based on two (or more) types for what is the same diatom, are much harder to recognize, and actually very little of the monographic work necessary to discover these conditions has been done. An example would be: *Gomphonema herculeanum* var. *robustum* Grunow has been shown to be the same diatom as *Gomphoneis herculeana* (Ehrenberg) Cleve (Kociolek & Stoermer 1988).

Another situation that could result in a proliferation of names is typographic and/or orthographic errors. Potential typographical errors were abundant in the literature consulted, and it is disconcerting to see how the same errors have been perpetuated from author to author. To reduce the number of entries due to these types of errors, I have, in some cases, made interpretations of these errors, especially in those situations when the context for the errors is more easy to interpret. For example, Loescher (1981, Table 1) lists "*Achnanthes lanceolate* (Bréb.) Grun. var. *lanceolata*" in her prairie samples, and I have treated this as an orthographic error for *Achnanthes lanceolata*. Likewise, Burkholder & Wetzel (1989) list "*Epithemia adriata* var. *proboscidea* (Kütz.) Patr. comb. nov." (interpreted here as *Epithemia adnata* var. *proboscidea)* and "*Fragilaria cortonensis* Kitt." (interpreted here as *Fragilaria crotonensis*), and as such I have not made separate entries for these orthographic errors.

I have not tracked synonymies in either the traditions of VanLandingham's *Catalogue* (1967-1979) or Camburn & Charles (2000). In most of the cases, there has actually been very little original research to support the nomenclatural combinations made or perpetuated. Monographic or revisionary studies, (including consultation of types) are needed to support the numerous nomenclatural changes made over the last decade or more.

References included in the bibliography were from the published literature only; no unpublished manuscripts, reports, theses or dissertations were included. In some cases, especially in the case of research reports issued from programs or centers based at universities or local government agencies, publication was not easy to ascertain. Experimental works *in situ* are cited, but references to artificial systems are not. Published exsiccatae are included. Paleolimnological studies are, generally, not included, except when surficial sediments were the focus of the study or report.

The basis for much of the literature surveyed was the Maillard Library and Diatom Collection Library of the California Academy of Sciences, the reprint collections of Van Landingham, Rushforth, and Stoermer (now all at CAS) and the published exsiccatae catalogue of Edgar (1987).

Results and Discussion

Taxa

A total of 167 genera and nearly 4500 names of diatoms at the level of species, variety or form are included in the list of diatoms (Section II: Species List of Diatoms of the United States). *Navicula* has the largest number of names reported (over 900), followed by *Pinnularia* (340), *Nitzschia* (325), *Gomphonema* (237) and *Eunotia* (223). Over forty genera are represented by a single name, and fifteen have only two names represented. Although many of these entries are nomenclatural synonyms, it is interesting to note that many others represent newly discovered taxa, in the context of monographic revisions (Krammer 1992, 1997a, 1997b; 2002; Reichart 1999; Hamilton et al. 1995; Kociolek & Stoermer 1988), water quality studies (Potapova & Charles 2002, 2003; Morales 2003) and floristics (Stachura-Suchoples et al., accepted; Siver et al. 2005).

Given the geogarphic size and complexity of the continental United States, the number of taxa in this compilation would appear modest compared to the check list developed for Great Britain (Hartley et al. 1986) and continental Europe (Krammer & Lange-Bertalot 1986, 1988, 1991a, 1991b). That the U.S. flora has been developed almost exclusively with European taxon descriptions and keys (e.g., Hustedt 1927–1966, 1930), or with an incomplete flora (Patrick & Reimer 1966, 1975) may have resulted in fewer taxa being reported from the country.

References

Over 1,200 citations are included in the Bibliography. There are over 150+ years of publications represented in this literature. The range of venues used to publish diatom reports includes those focused on phycology, botany, water quality assessment, state and local governments, federal government, water engineering, state academies, zoology, microscopy, ecology, hydrobiology, limnology and even speleology. These references show the importance of state and private academies in the development of our knowledge of diatoms, especially the Academy of Natural Sciences of Philadelphia, and the Iowa Academy of Science. University centers have been Iowa State University, the University of Michigan, Bowling Green State University and Michigan State University, with faculty member at the latter three part of a lineage that has its roots at Iowa State and ANSP. Another important research center has been Brigham Young University.

Some of the earliest reports on diatoms from U.S. freshwaters including sites from both coasts (e.g., Ehrenberg 1854), and while there was tremendous development of our knowledge beyond these early works in the northeast, other places (like the deep South) have not yet developed significantly beyond the earliest reports.

Areas that have been well-studied include the east coast, midwest, Great Lakes, Utah and Great Smoky Mountains National Park. Less studied areas include the southeastern U.S. (east, central and west), Pacific Northwest, California, and the Intermountain region.

We are likely to associate investigation of water quality with the "green" period of the 1960s and 1970s, and there is a tremendous amount of literature relating to water quality issues from that period. However, there was significant attention and interest in the diatom communities of what we would now call eutrophic environments, especially as it related to sources of freshwater for human communities as far back as the late 19th century (e.g., Thomas & Chase 1887).

Concluding Remarks

The number of floristic studies of the U.S. freshwater flora is relatively few, given the size and diversity of the country. Recent floristic studies in some of the most relatively well-known areas, such as the east coast, continue to discover new taxa (Siver et al. 2005; Stachura-Suchoples et al.

accepted), and monographic studies on some of the larger, more robust species in the genus *Gomphoneis* also identified many new taxa (Kociolek & Stoermer 1988). Thus, we still have a tremendous amount of work, floristic and monographic, to detail the diatoms of the U.S. Though the over 1,200 references included herein represent a large body of work, our knowledge of the flora has been constrained by the use of incomplete or European-based floras (Kociolek & Spaulding 2003).

I believe the majority of new discoveries of taxa will not only come from relatively unexplored areas of the country (such as the description of a new, apparently endemic genus from playa lakes in Arizona-Spaulding et al. 2002), but also from oligotrophic habitats. An indication of the potential for new discoveries from oligotrophic habitats comes from the work of Lange-Bertalot and Metzeltin (1996). They found in three oligotrophic lakes in Europe a total number of taxa equal to half of the total for all of Europe. Of the nearly 800 taxa found in these three oligotrophic lakes, over 125 were described as new or could not be assigned to known taxa.

It is imperative to better understand the biodiversity of diatoms in the United States. The roles they play in providing ecosystem services (base of the food chain, producers of oxygen) and their application to ecological problems, both theoretical and practical, provide strong rationales for a renewed commitment to develop the flora of the U.S. It is hoped this checklist, along with other tools, will facilitate work to the production of such a flora.

Acknowledgments

I am indebted in many ways to Gene Stoermer for his advice, guidance, and friendship. His insistence on high scientific standards has proven helpful beyond scientific endeavors. Dr. Elisabeth Fourtanier offered a constructive review of this manuscript as did Dr. Michele Aldrich.

Literature Cited

Boyer, C.S. 1927a. Synopsis of the North American Diatomaceae. *Proceedings of the Academy of Natural Sciences of Philadelphia* Supplement 78:1–228.

Boyer, C.S. 1927b. Synopsis of the North American Diatomaceae. *Proceeding of the Academy of Natural Sciences of Philadelphia* Supplement 79:229–583.

Burkholder, J.M., and R.G. Wetzel. 1989. Microbial colonization on natural and artificial macrophytes in a phosphorus-limited hardwater lake. *Journal of Phycology* 25:55–65.

Camburn, K.E., and D.F. Charles. 2000. *Diatoms of Low Alkalinity Lakes in the Northeastern United States.* Academy of Natural Sciences of Philadelphia, Special Publication 18. 152 pp.

Edgar, R.K. 1978. *The Jacob Whitman Bailey Diatom Collection at the Farlow Herbarium* [*of Harvard University*]. Farlow Herbarium, Cambridge, Massachusetts, USA. iii + 155 pp.

Ehrenberg, C.G. 1854. *Mikrogeologie. Das Erden und Felsen schaffende Wirken des unsichbar kleinen selbstständigen Lebens auf der Erde.* Leopold Voss, Leipzig, Germany. 374 pp.

Fourtanier, E., and J.P. Kociolek. 1999. Catalogue of the diatom genera. *Diatom Research* 14:1–190.

Fourtanier, E., and J.P. Kociolek. 2003. Addendum to the catalogue of diatom generic names. *Diatom Research* 18:245–258.

Hamilton, P.B., M. Poulin, and D. Walker. 1995. *Neidium hitchkockii* (Ehrenberg) Cleve, a morphologically complex taxon within the genus *Neidium* (Naviculales, Bacillariophyta). Pages 61–77 *in* J.P. Kociolek and M.J. Sullivan, eds., *A Century of Diatom Research in North America: A Tribute to the Distinguished Careers of Charles W. Reimer and Ruth Patrick.* Koeltz Scientific Books, Champaign, Illinois, USA.

Hartley, B., R. Ross, R., and D.M. Williams. 1986. A check-list of the freshwater, brackish and marine diatoms of the British Isles and adjoining coastal waters. *Journal of the Marine Biological Association of the United Kingdom* 66:531–610.

HUSTEDT, F. 1927–1966. *Die Kieselalgen Deutschlands, Österreichs und der Schwiez mit Berücksichtugung der übrigen Länder Europas sowie der Angrenzenden Meeresgebiete*. Rabenhorst Kryptogamenflora, Band VII. Teil 1: 1–920 (1927–1930); Teil 2: 1–845 (1931–1959); Teil 3: 1–816 (1961–1966). Leipzig, Germany.

HUSTEDT, F. 1930. Bacillariophyta. *In* A. Pascher, ed., *Süßwasserflora von Mitteleuropa*. Heft 10. Jena, Germany. 466p.

KOCIOLEK, J.P. (submitted). Some thoughts on the development of a diatom flora for freshwater ecosystems in the continental United States and a listing of Recent taxa described from U.S. freshwaters. *Proceedings of the California Academy of Sciences*.

KOCIOLEK, J.P., AND S.A. SPAULDING. 2003. General introduction to the diatoms. Pages 559–562 *in* J.D. Wehr and R.G. Sheath, eds., *Freshwater Algae of North America: Ecology and Classification*, Chapt. 15. Academic Press, Boston, Massachusetts, USA.

KOCIOLEK, J.P., AND E.F. STOERMER. 1988. Taxonomy, ultrastructure, and distribution of *Gomphoneis herculeana, G. eriense* and closely related species. *Proceedings of the Academy of Natural Sciences of Philadelphia* 140:24–97.

KRAMMER, K. 1992. *Pinnularia*. Eine Monographie der europäischen Taxa. *Bibliotheca Diatomologica* 26:1–353.

KRAMMER, K. 1997a. Die cymbelloiden Diatomeen. Eine Monographie der weltweit bekannten Taxa. Teil 1. Allgemeines und *Encyonema* Part. *Bibliotheca Diatomologica* 36:1–382.

KRAMMER, K. 1997b. Die cymbelloiden Diatomeen. Eine Monographie der weltweit bekannten Taxa. Teil 2. *Encyonema* Part., *Encyonopsis* und *Cymbellopsis*. *Bibliotheca Diatomologica* 37:1–469.

KRAMMER, K. 2002. The genus *Cymbella*. *In* H. Lange-Bertalot, ed., *Diatoms of Europe*, Vol. 3. A.R.G. Gantner, Verlag, Ruggell, Germany. 584 pp.

KRAMMER , K., AND H. LANGE-BERTALOT. 1986. Bacillariophyceae. Teil 2, Naviculaceae. *In* H. Ettl, J. Gerloff, H. Heynig, and D. Mollenhauer, eds., *Süßwasserflora von Mitteleuropa*, 2/1. Gustav Fisher, Stuttgart, Germany. 876 pp.

KRAMMER, K., AND H. LANGE-BERTALOT. 1988. Bacillariophyceae. Teil 2, Bacillariaceae, Epithemiaceae, Surirellaceae. In: H. Ettl, J. Gerloff, H. Heynig, and D. Mollenhauer, eds., *Süßwasserflora von Mitteleuropa*, 2/2. Gustav Fisher, Stuttgart, Germany. 596 pp.

KRAMMER, K., AND H. LANGE-BERTALOT. 1991a. Bacillariophyceae. Teil 2, Centrales, Fragilariaceae, Eunotiaceae. *In* H. Ettl, J. Gerloff, H. Heynig, and D. Mollenhauer, eds., *Süßwasserflora von Mitteleuropa*, 2/3. Gustav Fisher, Stuttgart, Germany. 576 pp.

KRAMMER, K., AND H. LANGE-BERTALOT. 1991b. Bacillariophyceae. Teil 2, Achnanthaceae. Kritische Erguanzungen zu Navicula (Lineolatae) und Gomphonema. *In* H. Ettl, G. Gärtner, J. Gerloff, H. Heynig, and D.Mollenhauer, eds., *Süßwasserflora von Mitteleuropa*, 2/4. Gustav Fisher, Stuttgart, Germany. 437 pp.

LANGE-BERTALOT, H., AND D. METZELTIN. 1996. Oligotrophie-Indikatoren. 800 Taxa repräsentativ für drei diverse Seen-Typen. *Iconographia Diatomologica* 2:1–390.

LOESCHER, J.H. 1981. Diatoms (Bacillariophyceae) from Sheeder Prairie, Guthrie County, Iowa. *Proceedings of the Iowa Academy of Science* 88:63–69.

MORALES, E.A. 2003. *Fragilaria pennsylvanica*, a new diatom (Bacillariophyceae) species from North America, with comments on the taxonomy of the genus *Synedra* Ehrenberg. *Proceedings of the Academy of Natural Sciences of Philadelphia* 153:155–166.

PATRICK, R.M., AND C.W. REIMER. 1966. *The Diatoms of the United States*. Academy of Natural Sciences of Philadelphia Monograph 13, Vol. 1. 688 pp.

PATRICK, R.M., AND C.W. REIMER. 1975. *The Diatoms of the United States*. Academy of Natural Sciences of Philadelphia Monograph 13, Vol. 2, Part 1. 213 pp.

POTAPOVA, M., AND D.F. CHARLES. 2002. Benthic diatom in USA rivers: distributions along spatial and environmental gradients. *Journal of Biogeography* 29:167–187.

POTAPOVA, M., AND D.F. CHARLES. 2003. Distribution of benthic diatoms in U.S. rivers in relation to conductivity and ionic composition. *Freshwater Biology* 48:1311–1328.

REICHARDT, E. 1999. Zur Revision der Gattung *Gomphonema*. Die Arten um *G. affine/insigne, G. angusta-*

tum/micropus, G. acuminatum sowie gomphonemoide Diatomeen aus dem Oberoligozän in Böhmen. *Iconographia Diatomologica* 8:1–203.

Siver, P.A., P.B. Hamilton, K. Stachura-Suchoples, and J.P. Kociolek. 2005. Freshwater diatom floras of North America: Cape Cod, Massachusetts, U.S.A. *Diatomologica Iconographia* 14:1–512.

Spaulding, S.A., J.P. Kociolek, and D. Davis. 2002. A new diatom genus from a playa lake in New Mexico, USA with the description of two new species. *European Journal of Phycology* 37:135–143.

Stachura-Suchoples, K., J.P. Kociolek, and P.A. Siver. (In press.) A new *Neidium* species from Florida (U.S.A.) and comparison with *N. densestriatum* (Østrup) Krammer. *Proceedings of the 17th International Diatom Symposium.*

Thomas, B.W., and H.H. Chase. 1887. The diatomaceae of Lake Michigan as collected during the last 16 years from the water supply of the city of Chicago. *Notarisia* 2:328–330.

Van Landingham, S. 1967–1979. *Catalogue of the Fossil and Recent Genera and Species of Diatoms and Their Synonyms.* Vols. 1–8. J. Cramer, Lehre, Germany. 4654 pp.

Section II: Species List of Diatoms of the United States

Name	Publication
Acanthoceras zachariasii (Brun) Simonsen	Stoermer et al. 1999
Achnanthes acares Hohn & Hellerman	Patrick & Reimer 1966
Achnanthes affinis Grunow	Stoermer & Kreis 1978
Achnanthes altaica (Poretzsky) A. Cleve	Stoermer et al. 1999
Achnanthes americana Cleve	Boyer 1927b
Achnanthes amoena Hustedt	Stoermer & Kreis 1978
Achnanthes atacamae Hustedt	Stoermer & Kreis 1978
Achnanthes austriaca Hustedt	Camburn 1982
Achnanthes austriaca var. helvetica Hustedt	Bateman & Rushforth 1984
Achnanthes biasolettiana (Kützing) Grunow	Stoermer & Kreis 1978
Achnanthes bicapitata Hustedt	Camburn & Charles 2000
Achnanthes biconfusa Van Landingham	Camburn et al. 1978
Achnanthes bioreti Germain	Stoermer & Kreis 1978
Achnanthes biporoma Hohn & Hellerman	Hohn & Hellerman 1963
Achnanthes bottnica (Cleve) Cleve	Rushforth & Merkley 1988
Achnanthes brevipes C. Agardh	Stoermer et al. 1999
Achnanthes brevipes var. intermedia (Kützing) Cleve	Stoermer et al. 1999
Achnanthes calcar Cleve	Stoermer & Kreis 1978
Achnanthes chlidanos Hohn & Hellerman	Camburn 1982
Achnanthes chilensis var. subaequalis Reimer	Whitford & Schumacher 1973
Achnanthes clevei Grunow	Stoermer & Kreis 1978
Achnanthes clevei var. rostrata Hustedt	Stoermer & Kreis 1978
Achnanthes coarctata (Brébisson) Grunow	Stoermer & Kreis 1978
Achnanthes conspicua A. Mayer	Stoermer & Kreis 1978
Achnanthes conspicua var. brevistriata Hustedt	Stoermer & Kreis 1978
Achnanthes cotteriensis Foged	Kaczmarska & Rushforth 1983
Achnanthes crenulata Grunow	Rushforth & Merkley 1988
Achnanthes curvirostrum Brun	Patrick & Reimer 1966
Achnanthes daui Foged	Potapova & Charles 2003
Achnanthes decipiens Reimer	Reimer 1966
Achnanthes deflexa Reimer	Stoermer & Kreis 1978
Achnanthes deflexa var. alpestris Lowe & Kociolek	Lowe & Kociolek 1984
Achnanthes delicatula (Kützing) Grunow	Stoermer & Kreis 1978
Achnanthes depressa (Cleve) Hustedt	Stoermer et al. 1999
Achnanthes detha Hohn & Hellerman	Stoermer & Kreis 1978
Achnanthes didyma Hustedt	Stoermer & Kreis 1978
Achnanthes dispar Cleve	Stoermer & Kreis 1978
Achnanthes dispar var. angulata Hustedt	Stoermer et al. 1999

Name	Publication
Achnanthes dispar var. fontellii A. Cleve	Stoermer et al. 1999
Achnanthes duthii Screenivasa	Stoermer et al. 1999
Achnanthes elliptica var. elongata A. Cleve	Stoermer & Kreis 1978
Achnanthes exigua Grunow	Stoermer & Kreis 1978
Achnanthes exigua var. constricta (Grunow) Hustedt	Stoermer & Kreis 1978
Achnanthes exigua var. elliptica Hustedt	Potapova & Charles 2003
Achnanthes exigua var. heterovalva Krasske	Stoermer & Kreis 1978
Achnanthes exigua var. heterovalva f. semiaperta Guermeur	Stoermer & Kreis 1978
Achnanthes exilis Kützing	Stoermer & Kreis 1978
Achnanthes flexella (Kützing) Brun	Stoermer & Kreis 1978
Achnanthes flexella var. alpestris Brun	Stoermer et al. 1999
Achnanthes gibberula Grunow	Stoermer et al. 1999
Achnanthes gracillima Hustedt	Stoermer & Kreis 1978
Achnanthes gracillina var. nipponica Sovereign	Stoermer et al. 1999
Achnanthes grana Hohn & Hellerman	Patrick & Reimer 1966
Achnanthes grimmei Krasske	Patrick & Reimer 1966
Achnanthes harveyi Reimer	Camburn 1982
Achnanthes hauckiana Grunow	Stoermer & Kreis 1978
Achnanthes hauckiana var. rostrata Schulz	Stoermer & Kreis 1978
Achnanthes helvetica (Hustedt) Lange-Bertalot	Camburn & Charles 2000
Achnanthes hettensis A. Cleve	Stoermer & Kreis 1978
Achnanthes hudsonis Grunow in Van Heurck	Patrick & Reimer 1966
Achnanthes hungarica (Grunow) Grunow	Stoermer & Kreis 1978
Achnanthes hustedtii (Krasske) Reimer	Patrick & Reimer 1966
Achnanthes imperfecta Schimanski	Camburn & Charles 2000
Achnanthes incognita Krasske	Stoermer et al. 1999
Achnanthes inflata (Kützing) Grunow	Camburn 1982
Achnanthes inflata var. elata (Leud.-Fortm.) Hustedt	Patrick & Reimer 1966
Achnanthes joursacense Héribaud	Stoermer et al. 1999
Achnanthes kolbei Hustedt	Stoermer et al. 1999
Achnanthes kryophila Peterson	Stoermer & Kreis 1978
Achnanthes kryophila var. africana Cholnoky	Stoermer & Kreis 1978
Achnanthes lanceolata (Brébisson) Grunow	Stoermer & Kreis 1978
Achnanthes lanceolata var. abbreviata Reimer	Hansmann 1973
Achnanthes lanceolata var. apiculata Patrick	Stoermer & Kreis 1978
Achnanthes lanceolata var. bimaculata Hustedt	Stoermer & Kreis 1978
Achnanthes lanceolata var. dubia Grunow	Stoermer & Kreis 1978
Achnanthes lanceolata var. elliptica Cleve	Stoermer & Kreis 1978
Achnanthes lanceolata var. fossilis	Patrick 1968
Achnanthes lanceolata var. genuina A. Mayer	Stoermer & Kreis 1978
Achnanthes lanceolata var. haynaldii (Schaarsch.) Cleve	Camburn & Lowe 1978
Achnanthes lanceolata var. lanceolatoides (Sovereign) Reimer	Collins & Kalinsky 1977
Achnanthes lanceolata f. minor Schultz	Whitford & Schumacher 1973
Achnanthes lanceolata var. omissa Reimer	Stoermer & Kreis 1978
Achnanthes lanceolata var. robusta Hustedt	Stoermer & Kreis 1978
Achnanthes lanceolata var. rhomboides A. Mayer	Gaufin et al. 1976
Achnanthes lanceolata var. rostrata Hustedt	Camburn 1982
Achnanthes lanceolata f. ventricosa Hustedt	VanLandingham 1968
Achnanthes lanceolatoides Sovereign	Stoermer & Kreis 1978
Achnanthes lapidosa Krasske	Stoermer & Kreis 1978
Achnanthes lapidosa var. appalachiana (Camburn & Lowe) Lange-Bertalot	Camburn & Charles 2000
Achnanthes lapidosa var. lanceolata	Patrick & Roberts 1979
Achnanthes lapponica (Hustedt) Hustedt	Collins & Kalinsky 1977
Achnanthes lapponica var. fennica A. Cleve	Clark & Rushforth 1977
Achnanthes lapponica var. ninckei (Guerm. & Manguin) Reimer	Camburn 1982
Achnanthes laterostrata Hustedt	Stoermer & Kreis 1978
Achnanthes lauenburgiana Hustedt	Stoermer & Kreis 1978

Name	Publication
Achnanthes lemmermannii Hustedt	Stoermer & Kreis 1978
Achnanthes levanderi Hustedt	Stoermer & Kreis 1978
Achnanthes levanderi var. helvetica Hustedt	Stoermer et al. 1999
Achnanthes lewisiana Patrick	Stoermer & Kreis 1978
Achnanthes linearis (W. Smith) Grunow	Stoermer & Kreis 1978
Achnanthes linearis var. pusilla Grunow	Stoermer & Kreis 1978
Achnanthes linearis f. curta H.L. Smith	Stoermer & Kreis 1978
Achnanthes linearis f. linearis	Andresen & Stoermer 1978
Achnanthes lutheri Hustedt	Hansmann 1973
Achnanthes macrocephala (Kützing) Grunow	Gaufin et al. 1976
Achnanthes marginulata Grunow	Stoermer & Kreis 1978
Achnanthes microcephala (Kützing) Grunow	Stoermer & Kreis 1978
Achnanthes minutissima Kützing	Stoermer & Kreis 1978
Achnanthes minutissima var. cryptocephala Grunow	Stoermer & Kreis 1978
Achnanthes minutissima var. macrocephala Hustedt	Hohn & Hellerman 1963
Achnanthes minutissima var. robusta Hustedt	Stoermer & Kreis 1978
Achnanthes monela Hohn & Hellerman	Hohn & Hellerman 1963
Achnanthes montana Krasske	Clark & Rushforth 1977
Achnanthes nitiformis Lange-Bertalot	Siver et al. 2005
Achnanthes nodosa A. Cleve	Stoermer & Kreis 1978
Achnanthes nollii Bock	Stoermer & Kreis 1978
Achnanthes oblongella Østrup	Camburn & Charles 2000
Achnanthes oestrupi (A. Cleve) Hustedt	Stoermer & Kreis 1978
Achnanthes oestrupi var. lanceolata Hustedt	Stoermer & Kreis 1978
Achnanthes oestrupii var. parvula Patrick	Patrick 1945
Achnanthes oestrupii var. pungens (A. Cleve) Lange-Bertalot	Stoermer et al. 1999
Achnanthes orientalis Petit	Rushforth & Merkley 1988
Achnanthes pachypus Montagne	Patrick & Reimer 1966
Achnanthes peragalli Brun & Héribaud	Stoermer & Kreis 1978
Achnanthes peragalli var. fossilis Tempère & Peragallo	Stoermer & Kreis 1978
Achnanthes peragalli var. parvula (Patrick) Reimer	Stoermer & Kreis 1978
Achnanthes pericava Carter	Gaiser & Johansen 2000
Achnanthes pinnata Hustedt	Stoermer & Kreis 1978
Achnanthes ploenensis Hustedt	Stoermer & Kreis 1978
Achnanthes prava Sovereign	Patrick & Reimer 1966
Achnanthes procera Hustedt	Stoermer & Kreis 1978
Achnanthes pseudolinearis Hustedt	Camburn 1982
Achnanthes pseudoobliqua Simonsen	Kalinsky 1983
Achnanthes pseudotanensis A. Cleve	Patrick & Reimer 1966
Achnanthes pusilla Grunow in Cleve & Grunow	Hamilton et al. 1992
Achnanthes quadratarea (Østrup) Möller ex Foged	Hamilton et al. 1992
Achnanthes recurvata Hustedt	Stoermer et al. 1999
Achnanthes reimeri Camburn	Camburn 1982
Achnanthes ricula Hohn & Hellerman	Hohn & Hellerman 1963
Achnanthes rosenstockii Lange-Bertalot	Camburn & Charles 2000
Achnanthes rostrata Østrup	Hamilton et al. 1992
Achnanthes rupestoides Hohn	Patrick & Reimer 1966
Achnanthes saxonica Krasske	Patrick & Reimer 1966
Achnanthes simplex Hustedt	Kaczmarska & Rushforth 1983
Achnanthes stewartii Patrick	Camburn 1982
Achnanthes subatomus Hustedt	Hohn & Hellerman 1963
Achnanthes subhudsonis var. kraeuselii Cholnoky	Hohn & Hellerman 1963
Achnanthes sublaevis Hustedt	Stoermer & Kreis 1978
Achnanthes sublaevis var. crassa Reimer	Camburn 1982
Achnanthes submarina Hustedt	Kalinsky 1983
Achnanthes subrostrata Hustedt	Dodd 1987
Achnanthes subrostrata var. appalachiana Camburn & Lowe	Camburn 1982

Name	Publication
Achnanthes subsaloides Hustedt	Stoermer & Kreis 1978
Achnanthes subsalsa Petersen	
Achnanthes subsessilis Kützing	Kalinsky 1983
Achnanthes suchlandtii Hustedt	Stoermer & Kreis 1978
Achnanthes taeniata Grunow in Cleve & Grunow	Patrick & Roberts 1979
Achnanthes temperei Peragallo in Tempère & Peragallo	Boyer 1927b
Achnanthes thermalis (Rabenhorst) Schonfeld	Stoermer et al. 1999
Achnanthes trinodis (W. Smith) Grunow	Stoermer & Kreis 1978
Achnanthes tropica Hustedt	Kaczmarska & Rushforth 1983
Achnanthes ventralis (Krasske) Lange-Bertalot	Stoermer et al. 1999
Achnanthes ventraloconfusa f. simplex Lange-Bertalot	Stoermer et al. 1999
Achnanthes ventricosa Ehrenberg	Tempère & Peragallo 1909
Achnanthes wellsiae Reimer	Stoermer & Kreis 1978
Achnanthidium affine (Grunow) Czarnecki	Stoermer et al. 1999
Achnanthidium alpestre (Lowe & Kociolek) Lowe & Kociolek in Johansen et al.	Potapova & Ponader 2004
Achnanthidium bioreti (Germain) Edlund	Stoermer et al. 1999
Achnanthidium brevipes var. intermedia (Kützing) Cleve	Stoermer et al. 1999
Achnanthidium clevei (Grunow in Cleve & Grunow) Czarnecki	Stoermer et al. 1999
Achnanthidium clevei var. rostratum (Hustedt) Edlund	Stoermer et al. 1999
Achnanthidium crassum (Hustedt) Potapova & Ponader	Potapova & Ponader 2004
Achnanthidium deflexum (Reimer) Kingston	Potapova & Charles 2003
Achnanthidium delicatulum Kützing	Stoermer et al. 1999
Achnanthidium duthii (Sreen.) Edlund	Stoermer et al. 1999
Achnanthidium exiguum (Grunow) Czarnecki	Stoermer et al. 1999
Achnanthidium exiguum var. constrictum (Grunow) Andresen et al.	Andresen et al. 2000
Achnanthidium exiguum var. heterovalvum (Krasske) Czarnecki	Stoermer et al. 1999
Achnanthidium exilis (Kützing) Bukhtiyarova	Stoermer et al. 1999
Achnanthidium flexellum (Kützing) Brébisson	Stoermer & Kreis 1978
Achnanthidium hauckianum (Grunow) Czarnecki	Stoermer et al. 1999
Achnanthidium hungaricum Grunow	Stoermer et al. 1999
Achnanthidium kryophila (Petersen) Bukhtiyarova	Stoermer et al. 1999
Achnanthidium lanceolatum Brébisson in Kützing	Stoermer et al. 1999
Achnanthidium lanceolatum var. elliptica Cleve	Stoermer et al. 1999
Achnanthidium lanceolatum var. genuinum Mayer	Stoermer et al. 1999
Achnanthidium lanceolata var. haynaldii (Schaarsch.) Cleve	Stoermer et al. 1999
Achnanthidium lapponicum Hustedt	Hohn 1951
Achnanthidium levanderi (Hustedt) Czarnecki	Stoermer et al. 1999
Achnanthidium lineare W. Smith	Stoermer et al. 1999
Achnanthidium microcephalum (Kützing) vide Rabenhorst	Stoermer et al. 1999
Achnanthidium minutissimum (Kützing) Czarnecki	Stoermer et al. 1999
Achnanthidium peragalli Brun & Héribaud in Héribaud	Stoermer et al. 1999
Achnanthidium rivulare Potapova & Ponader	Potapova & Ponader 2004
Achnanthidium semiaperta (Guermeur) Andresen et al.	Andresen et al. 2000
Achnanthidium trinodis Arnott ex Ralfs in Pritchard	Stoermer et al. 1999
Actinella punctata Lewis	Boyer 1927a
Actinocyclus australis Grunow	Tempère & Peragallo 1913
Actinocyclus barkelyi Grunow	Tempère & Peragallo 1913
Actinocyclus niagarae H.L. Smith	Stoermer & Kreis 1978
Actinocyclus normanii (Gregory) Hustedt	Stoermer et al. 1999
Actinocyclus normanii f. subsalsa (Juhl.-Dannf.) Hustedt	Stoermer et al. 1999
Actinoptychus sp.	Stoermer & Kreis 1978
Adlafia suchlandtii (Hustedt) Lange-Bertalot in Moser et al.	Johansen et al. 2004

Name	Publication
Amphicampa eruca Ehrenberg	Boyer 1927a
Amphicampa hemicyclus (Ehrenberg) Karsten	Rushforth & Merkley 1988
Amphicampa mirabilis Ehrenberg ex Ralfs	Patrick & Reimer 1966
Amphipleura artica Patrick & Freese	Stoermer & Kreis 1978
Amphipleura kriegeriana (Krasske) Hustedt	Stoermer et al. 1999
Amphipleura lindheimeri Grunow	Patrick & Reimer 1966
Amphipleura pellucida (Kützing) Kützing	Stoermer & Kreis 1978
Amphipleura rutilans (Trentepohl) Cleve	Rushforth & Merkley 1988
Amphipleura sigmoidea W. Smith	Stoermer & Kreis 1978
Amphiprora alata (Ehrenberg) Kützing	Stoermer & Kreis 1978
Amphiprora calumetica Thomas	Stoermer & Kreis 1978
Amphiprora conspicua Greville	Patrick & Reimer 1975
Amphiprora costata Hustedt	Whitford & Schumacher 1973
Amphiprora navicularis Ehrenberg	Ehrenberg 1856
Amphiprora nereis Lewis	Patrick & Reimer 1975
Amphiprora ornata J.W. Bailey	Stoermer & Kreis 1978
Amphiprora paludosa W. Smith	Stoermer & Kreis 1978
Amphiprora pulchra J.W. Bailey	J.W. Bailey 1851
Amphitropis ornata (J.W. Bailey) Grunow	Stoermer & Kreis 1978
Amphitropis paludosa var. duplex Donkin	Cleve & Möller 1879
Amphitropis paludosa var. pokorniana Grunow	Cleve & Möller 1879
Amphora acutiuscula Kützing	Patrick & Reimer 1975
Amphora amphioxys J.W. Bailey	Ehrenberg 1856
Amphora angularis Gregory	Kalinsky 1983
Amphora angusta Gregory	Patrick & Reimer 1975
Amphora angusta var. oblongella Grunow	Kalinsky 1983
Amphora angusta var. ventricosa (Gregory) Cleve	Kalinsky 1983
Amphora aponina Kützing	Patrick & Reimer 1975
Amphora arcus var. sulcata (A. Smith) Cleve	Kaczmarska & Rushforth 1983
Amphora birugula Hohn	Camburn 1982
Amphora bullatoides Hohn & Hellerman	Stoermer & Kreis 1978
Amphora calumetica (Thomas) M. Peragallo	Stoermer & Kreis 1978
Amphora caroliniana Giffen	Kalinsky 1983
Amphora cistula var. maculata (Kützing) Van Heurck	Prescott & Dillard 1979
Amphora clevei Grunow in A. Schmidt	Patrick & Reimer 1975
Amphora coffeaeformis (Agardh) Kützing	Stoermer & Kreis 1978
Amphora coffeaeformis var. acutiuscula (Kützing) Kützing	Stoermer & Kreis 1978
Amphora coffeaeformis var. fossilis Pantocsek	Kaczmarska & Rushforth 1983
Amphora coffeaeformis var. perpusilla Grunow	Kaczmarska & Rushforth 1983
Amphora coffeiformis var. salinarum Grunow	Patrick & Reimer 1975
Amphora cognata Cholnoky	Rushforth & Merkley 1988
Amphora commutata Grunow	Stoermer & Kreis 1978
Amphora crassa Gregory	Rushforth & Merkley 1988
Amphora crucifera A. Cleve	Stoermer et al. 1999
Amphora cruciferoides Stoermer & Yang	Stoermer & Kreis 1978
Amphora cymbifera Gregory	Patrick & Reimer 1975
Amphora delicatissima Krasske	Stoermer & Kreis 1978
Amphora delphina L. W. Bailey	Boyer 1927b
Amphora delphinea var. minor	Tempère & Peragallo 1911
Amphora exigua Gregory	Stoermer & Kreis 1978
Amphora fonticola Maillard	Stoermer & Kreis 1978
Amphora fontinalis Hustedt	Camburn 1982
Amphora fusca A. Schmidt	Gaiser & Johansen 2000
Amphora gigas Ehrenberg	Stoermer & Kreis 1978

Name	Publication
Amphora gracilis	Ehrenberg 1856
Amphora granulata Gregory	Kalinsky 1983
Amphora hemicycla Stoermer & Yang	Stoermer & Kreis 1978
Amphora holsatica Hustedt	Patrick & Reimer 1975
Amphora huronensis Stoermer & Yang	Stoermer & Kreis 1978
Amphora hyalina Kützing	Kaczmarska & Rushforth 1983
Amphora inariensis Krammer	Stoermer et al. 1999
Amphora libyca Ehrenberg	Stoermer & Kreis 1978
Amphora lineata Gregory	Patrick & Reimer 1975
Amphora lineolata (Ehrenberg) Ehrenberg	Prescott & Dillard 1979
Amphora macilenta Gregory	Kaczmarska & Rushforth 1983
Amphora marina (W. Smith) Van Heurck	Rushforth & Merkley 1988
Amphora menisca Hohn & Hellerman	Hohn & Hellerman 1963
Amphora michiganensis Stoermer & Yang	Stoermer & Kreis 1978
Amphora montana Krasske	Stoermer & Kreis 1978
Amphora neglecta Stoermer & Yang	Stoermer & Kreis 1978
Amphora normanii Rabenhorst	Stoermer & Kreis 1978
Amphora ocellata	Ehrenberg 1856
Amphora oligotraphenta Lange-Bertalot	Stoermer et al. 1999
Amphora ovalis (Kützing) Kützing	Stoermer & Kreis 1978
Amphora ovalis var. affinis (Kützing) Van Heurck ex De Toni	Camburn 1982
Amphora ovalis var. constricta Skvortzow	Stoermer & Kreis 1978
Amphora ovalis var. gracilis (Ehrenberg) Van Heurck	Stoermer & Kreis 1978
Amphora ovalis var. libyca (Ehrenberg) Cleve	Stoermer & Kreis 1978
Amphora ovalis var. minor H.H. Chase	Stoermer & Kreis 1978
Amphora ovalis var. minutissima (W. Smith) Hurter	Stoermer & Kreis 1978
Amphora ovalis var. pediculus (Kützing). Van Heurck	Stoermer & Kreis 1978
Amphora parallelistriata Manguin	Stoermer & Kreis 1978
Amphora parallelistriata var. manguinii Carter	Clark & Rushforth 1977
Amphora pediculus var. minor Grunow	Whitford & Schumacher 1973
Amphora pellucida Gregory	Patrick & Reimer 1975
Amphora perpusilla (Grunow) Grunow	Stoermer & Kreis 1978
Amphora proteus Gregory	Patrick & Reimer 1975
Amphora proteus var. oculata Peragallo	Kaczmarska & Rushforth 1983
Amphora rimosa Ehrenberg	Patrick & Reimer 1975
Amphora rotunda Skvortzow	Stoermer & Kreis 1978
Amphora sabiniana Reimer	Patrick & Reimer 1975
Amphora salina W. Smith	Elmore 1922
Amphora sibirica Skvortzow in Skvortzow & Meyer	Stoermer & Kreis 1978
Amphora subcostulata Stoermer & Yang	Stoermer & Kreis 1978
Amphora submontana Hustedt	Camburn 1982
Amphora tenerrima Hustedt	Kalinsky 1983
Amphora tenuissima Hustedt	Kaczmarska & Rushforth 1983
Amphora tenuistriata Manguin	Hohn & Hellerman 1963
Amphora thermalis Hustedt	Drum 1981
Amphora thumensis (Mayer) A. Cleve	Stoermer et al. 1999
Amphora turgida Gregory	Patrick & Reimer 1975
Amphora veneta Kützing	Stoermer & Kreis 1978
Amphora veneta var. angularis	Stoermer & Kreis 1978
Amphora veneta var. capitata Haworth	Stoermer & Kreis 1978
Amphora ventricosa Gregory	Kalinsky 1983
Aneumastus carolinianus (Patrick) Lange-Bertalot	Lange-Bertalot 2001
Aneumastus minor (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Aneumastus stroesei (Østrup) Mann in Round et al.	Stoermer et al. 1999
Aneumastus tusculus (Ehrenberg) Mann in Round et al.	Stoermer et al. 1999
Aneumastus tusculus f. minor (Hustedt) Andresen et al.	Andresen et al. 2000

Name	Publication
Aneumastus tusculus f. obtusum (Hustedt) Andresen et al.	Andresen et al. 2000
Aneumastus tusculus var. rostratus (Hustedt) Andresen et al.	Andresen et al. 2000
Anomoeoneis brachysira (Brébisson) Grunow	Camburn & Charles 2000
Anomoeoneis brachysira var. zellensis (Grunow) Krammer	Camburn & Charles 2000
Anomoeoneis costata (Kützing) Hustedt	Stoermer & Kreis 1978
Anomoeoneis exilis Kützing	Stoermer & Kreis 1978
Anomoeoneis exilis var. lanceolata A. Mayer	Bateman & Rushforth 1984
Anomoeoneis exilis var. thermalis (Grunow) Cleve	Patrick & Reimer 1966
Anomoeoneis fogedii Reimer	Reimer 1982
Anomoeoneis follis (Ehrenberg) Cleve	Stoermer & Kreis 1978
Anomoeoneis follis var. hannae Reimer	Patrick & Reimer 1966
Anomoeoneis follis var. fossilis Reimer	Patrick & Reimer 1966
Anomoeoneis paludigena Scherer	Scherer 1988
Anomoeoneis polygramma (Ehrenberg) Cleve	Rushforth & Merkley 1988
Anomoeoneis polygramma var. platensis Frenguelli	Patrick & Reimer 1966
Anomoeoneis sculpta (Ehrenberg) O. Müller	Stoermer & Kreis 1978
Anomoeoneis sculpta var. major Cleve	Patrick & Reimer 1966
Anomoeoneis serians Brébisson	Stoermer & Kreis 1978
Anomoeoneis serians f. undulata Hustedt	Hustedt 1959
Anomoeoneis serians var. acuta Hustedt	Hansmann 1973
Anomoeoneis serians var. apiculata (Lewis) Boyer	Boyer 1927b
Anomoeoneis serians var. brachysira (Brébisson) Hustedt	Stoermer & Kreis 1978
Anomoeoneis serians var. brachysira f. thermalis (Grunow) Hustedt	Sovereign 1958
Anomoeoneis serians var. minor Grunow	Boyer 1927b
Anomoeoneis sphaerophora (Ehrenberg) Pfitzer	Stoermer & Kreis 1978
Anomoeoneis sphaerophora var. biceps Ehrenberg	Ehrenberg 1856
Anomoeoneis sphaerophora f. costata (Kützing) A.M. Schmid	Stoermer et al. 1999
Anomoeoneis sphaerophora var. guentheri O. Müller	Patrick & Reimer 1966
Anomoeoneis sphaerophora var. minor Kociolek & Herbst	Kociolek & Herbst 1992
Anomoeoneis sphaerophora var. sculpta (Ehrenberg) O. Müller	Stoermer & Kreis 1978
Anomoeoneis styriaca (Grunow) Hustedt	Stoermer & Kreis 1978
Anomoeoneis variabilis (Ross) Reimer	Reimer 1966
Anomoeoneis vitrea (Grunow) Ross	Stoermer & Kreis 1978
Anomoeoneis vitrea f. lanceolata (A. Mayer) Mogh.	Gaufin et al. 1976
Anomoeoneis vitrea var. gomphonemacea (Grunow) Mogh.	Gaufin et al. 1976
Anomoeoneis zellensis (Grunow) Cleve	Stoermer & Kreis 1978
Anomoeoneis zellensis f. difficilis (Grunow in Van Heurck) Hustedt	Stoermer et al. 1999
Anorthoneis dulcis Hein	Hein 1991
Asterionella bleakleyi W. Smith	Stoermer & Kreis 1978
Asterionella formosa Hassall	Stoermer & Kreis 1978
Asterionella formosa var. acaroides Lemmerman	Stoermer & Kreis 1978
Asterionella formosa var. gracillima (Hantzsch) Grunow in Van Heurck	Stoermer & Kreis 1978
Asterionella formosa var. subtilis Grunow	Stoermer & Kreis 1978
Asterionella formosa var. subtilissima Grunow	Starrett & Patrick 1952
Asterionella gracillima (Hantzsch) Heiberg	Stoermer & Kreis 1978
Asterionella ralfsii W. Smith	Patrick 1945
Asterionella ralfsii var. americana Korner	Dixit & Smol 1995
Attheya zachariasi Brun	Stoermer & Kreis 1978
Aulacoseira agassizii (Ostenfeld) Simonsen	Stoermer et al. 1999
Aulacoseira agassizii var. malayensis (Hustedt) Simonsen	Stoermer et al. 1999
Aulacoseira alpigena (Grunow) Krammer	Stoermer et al. 1999
Aulacoseira ambigua (Grunow) Simonsen	Stoermer et al. 1999

Name	Publication
Aulacoseira canadensis (Hustedt) Simonsen	Stoermer et al. 1999
Aulacoseira crassipunctata Krammer	Camburn & Charles 2000
Aulacoseira distans (Ehrenberg) Simonsen	Stoermer et al. 1999
Aulacoseira distans var. africana (O. Müller) Simonsen	Hamilton et al. 1992
Aulacoseira distans var. alpigena (Ehrenberg) Simonsen	Camburn 1982
Aulacoseira distans var. limnetica (O. Müller) Simonsen	Stoermer et al. 1999
Aulacoseira distans var. nivalis (W. Smith) Haworth	Camburn & Charles 2000
Aulacoseira distans var. nivaloides (Camburn) Haworth	Hamilton et al. 1992
Aulacoseira distans var. septentrionalis Camburn & Charles	Camburn & Charles 2000
Aulacoseira distans var. tenella (Nygaard) Ross in Hartley	Hamilton et al. 1992
Aulacoseira granulata (Ehrenberg) Simonsen	Camburn 1982
Aulacoseira granulata var. angustissima (O. Müller) Simonsen	Camburn 1982
Aulacoseira granulata var. angustissima f. spiralis (Hustedt) Czarnecki & Reinke	Stoermer et al. 1999
Aulacoseira granulata var. muzzanensis (Meister) Simonsen	Stoermer et al. 1999
Aulacoseira herzogii Lemmermann	Hickel & Håkansson 1991
Aulacoseira humilis (Cleve-Euler) Simonsen	Camburn & Charles 2000
Aulacoseira islandica (O. Müller) Simonsen	Stoermer et al. 1999
Aulacoseira islandica subsp. helvetica (O. Müller) Simonsen	Stoermer et al. 1999
Aulacoseira italica (Ehrenberg) Simonsen	Stoermer et al. 1999
Aulacoseira italica var. tenuissima (Grunow) Simonsen	Stoermer et al. 1999
Aulacoseira italica var. valida (Grunow) Simonsen	Stoermer et al. 1999
Aulacoseira italica subsp. subarctica (O. Müller) Simonsen	Stoermer et al. 1999
Aulacoseira lacustris (Grunow) Krammer	Camburn & Charles 2000
Aulacoseira lirata (Ehrenberg) Kützing	Hamilton et al. 1992
Aulacoseira lirata var. biseriata (Grunow) Haworth	Hamilton et al. 1992
Aulacoseira lirata var. lacustris (Grunow) Ross in Haartley	Hamilton et al. 1992
Aulacoseira lirata var. alpigena (Grunow) Haworth	Stoermer et al. 1999
Aulacoseira lirata var. perglabra (Østrup) Ross in Hartley	Hamilton et al. 1992
Aulacoseira lirata var. perglabra f. florinae (Camburn) Haworth	Hamilton et al. 1992
Aulacoseira nygaardii (Camburn) Camburn in Camburn & Charles	Hamilton et al. 1992
Aulacoseira perglabra (Østrup) Haworth	Camburn & Charles 2000
Aulacoseira perglabra var. floriniae (Camburn) Haworth	Camburn & Charles 2000
Aulacoseira subarctica (O. Müller) Haworth	Stoermer et al. 1999
Aulacoseira tenella (Nygaard) Simonsen	Camburn & Charles 2000
Aulacoseira valida (Grunow) Krammer	Stoermer et al. 1999
Bacillaria furcata	Ehrenberg 1856
Bacillaria cuneata	Ehrenberg 1856
Bacillaria paradoxa Gmelin	Stoermer & Kreis 1978
Bacillaria paradoxa var. tumidula Grunow	Collins & Kalinsky 1977
Bacillaria paxillifer (O.F. Müller) Hendey	Stoermer & Kreis 1978
Bacillaria vulgaris	Ehrenberg 1856
Biddulphia laevis Ehrenberg	Camburn 1982
Biddulphia polymorpha Ehrenberg	Whitford 1956
Biremis circumtexta (Meister) Lange-Bertalot & Witkowski	Potapova & Charles 2003
Biremis undulata (Schulz) Andresen et al.	Edlund et al. 2001
Biremis zachariasi (Reichelt) Edlund et al.	Edlund et al. 2001
Brachysira aponina Kützing	Kaczmarska & Rushforth 1983
Brachysira arctoborealis Wolfe & Kling	Wolfe & Kling 2001
Brachysira brebissonii Ross	Potapova & Charles 2003
Brachysira exilis (Kützing) Round & D.G. Mann	Stoermer et al. 1999
Brachysira exilis f. undulata Kisselev	Kaczmarska & Rushforth 1983
Brachysira follis (Ehrenberg) R. Ross in Hartley	Stoermer et al. 1999
Brachysira gravida Shayler & Siver	Shayler & Siver 2004

Name	Publication
Brachysira brebissonii R. Ross in Hartley	Stoermer et al. 1999
Brachysira microcephala (Grunow) Compère	Potapova & Charles 2003
Brachysira neoacuta Lange-Bertalot	Gaiser & Johansen 2000
Brachysira neoexilis Lange-Bertalot	Potapova & Charles 2002
Brachysira serians (Brébisson ex Kützing) Round & D.G. Mann	Stoermer et al. 1999
Brachysira serians var. acuta (Hustedt) Hamilton in Hamilton et al.	Hamilton et al. 1992
Brachysira sphaerophora (Kützing) Round & D.G. Mann	Stoermer et al. 1999
Brachysira styriaca (Grunow in Van Heurck) R. Ross in Hartley	Stoermer et al. 1999
Brachysira vitrea (Grunow) R. Ross in Hartley	Stoermer et al. 1999
Brachysira zellensis (Grunow) Round & D.G. Mann	Stoermer et al. 1999
Brachysira zellensis f. difficilis (Grunow in Van Heurck) Hamilton in Hamilton et al.	Stoermer et al. 1999
Brebissonia boeckii (Ehrenberg) Grunow	Boyer 1927b
Brebissonia interposita (Lewis) Kuntze	Elmore 1922
Brebissonia palmeri Boyer	Smith 1950
Brebissonia vulgaris (Thwaites) Van Heurck	Elmore 1922
Caloneis aequatorialis Hustedt	Dodd 1987
Caloneis aerophila Bock	Collins & Kalinsky 1977
Caloneis alpestris (Grunow) Cleve	Stoermer & Kreis 1978
Caloneis amphisbaena (Bory) Cleve	Stoermer & Kreis 1978
Caloneis amphisbaena var. subsalina (Donkin) Cleve	Hohn 1951
Caloneis bacillaris (Gregory) Cleve	Stoermer & Kreis 1978
Caloneis bacillaris var. thermalis (Grunow) A. Cleve	Stoermer & Kreis 1978
Caloneis bacillum (Grunow) Cleve	Stoermer & Kreis 1978
Caloneis bacillum var. angusta A. Mayer	Dodd 1987
Caloneis bacillum f. fonticola (Grunow) A. Mayer	Dodd 1987
Caloneis bacillum var. fontinalis Hustedt	Stoermer & Kreis 1978
Caloneis bacillum var. lancettula (Schulz) Hustedt	Stoermer & Kreis 1978
Caloneis backmanii A. Cleve	Czarnecki & Blinn 1978
Caloneis clevei (Lagesterdt) Cleve	Stoermer & Kreis 1978
Caloneis clevei var. undulata Krasske	Stoermer et al. 1999
Caloneis columbiensis Cleve	Boyer 1927b
Caloneis fasciata (lagestedt) Cleve	Boyer 1927b
Caloneis fenzlii (Grunow) Patrick	Patrick & Reimer 1966
Caloneis fenzlioides Cleve-Euler	Rushforth & Squires 1985
Caloneis fontinalis (Grunow) Kange-Bertalot & Reichardt	Stoermer et al. 1999
Caloneis formosa Gregory	Stoermer & Kreis 1978
Caloneis hebes (Ralfs) Patrick	Patrick & Reimer 1966
Caloneis holstii Cleve	Cleve 1894
Caloneis hultenii Petersen	Dodd 1987
Caloneis hyalina Hustedt	Stoermer & Kreis 1978
Caloneis lagerstedtii Cholnoky	Dodd 1987
Caloneis lamella Zakrzewski	Collins & Kalinsky 1977
Caloneis lancettula (Schulz) Lange-Bertalot & Witkowski	Stoermer et al. 1999
Caloneis latiuscula var. reimeri Czarnecki & Blinn	Czarnecki 1979
Caloneis lenzii Krasske	Dodd 1987
Caloneis leptosoma (Grunow) Krammer	Stoermer et al. 1999
Caloneis lewisii Patrick	Stoermer & Kreis 1978
Caloneis lewisii var. inflata (Schultze) Patrick	Patrick & Reimer 1966
Caloneis liber (W. Smith) Cleve	Stoermer et al. 1999
Caloneis limosa (Kützing) Patrick	Stoermer & Kreis 1978
Caloneis limosa var. gibberula (Kützing) Grunow	Stoermer et al. 1999
Caloneis limosa var. subinflata Grunow	Stoermer et al. 1999
Caloneis limosa var. undulata Grunow	Stoermer et al. 1999
Caloneis molaris (Grunow) Krammer	Stoermer et al. 1999
Caloneis nubicola (Grunow) Cleve	Stoermer & Kreis 1978

Name	Publication
Caloneis obtusa (W. Smith) Cleve	Boyer 1927b
Caloneis oregonica (Ehrenberg) Patrick	Grimes & Rushforth 1982
Caloneis permagna (Bailey) Cleve	Rushforth & Squires 1985
Caloneis permagna var. lewisiana Boyer	Starrett & Patrick 1952
Caloneis pseudoclevei Cholnoky	Patrick & Reimer 1966
Caloneis pseudoschummaniana (Hustedt) Simonsen	Simonsen 1987
Caloneis pulchra Messik	Stoermer & Kreis 1978
Caloneis pulchra var. interrupta Gandhi	Stoermer & Kreis 1978
Caloneis salebrastriata Hohn	Patrick & Reimer 1966
Caloneis schumanniana (Grunow) Cleve	Stoermer & Kreis 1978
Caloneis schumanniana var. biconstricta Grunow	Stoermer & Kreis 1978
Caloneis schumanniana var. biconstricta f. baikalensis Skv.	Johansen et al. 2004
Caloneis schumanniana var. fasciata Hustedt	Grimes & Rushforth 1982
Caloneis schumanniana var. lancettula Hustedt	Stoermer et al. 1999
Caloneis schumanniana var. linearis Hustedt	Grimes & Rushforth 1982
Caloneis silicula (Ehrenberg) Cleve	Stoermer & Kreis 1978
Caloneis silicula var. alpina Cleve	Patrick 1945
Caloneis silicula var. brevistriata O. Müller	Czarnecki & Blinn 1978
Caloneis silicula var. gibberula (Kützing) Cleve	Boyer 1927b
Caloneis silicula var. inflata (Grunow) Cleve	Boyer 1927b
Caloneis silicula var. minuta (Grunow) Cleve	Patrick 1961
Caloneis silicula var. truncatula (Grunow) Meister	Stoermer & Kreis 1978
Caloneis silicula var. limosa Van Landingham	Stoermer et al. 1999
Caloneis silicula var. tumida Hustedt	Czarnecki & Blinn 1978
Caloneis silicula var. undulata (Grunow) Cleve	Stoermer et al. 1999
Caloneis silicula var. ventricosa	Patrick 1968
Caloneis speciosa (Hustedt) Boyer	Boyer 1927b
Caloneis tenuis (Gregory) Krammer	Stoermer et al. 1999
Caloneis trinodis (Lewis) Boyer	Boyer 1927b
Caloneis trinodis var. inflata Schultze	Patrick & Reimer 1966
Caloneis undosa Krammer	Camburn & Charles 2000
Caloneis undulata (Gregory) Krammer	Stoermer et al. 1999
Caloneis ventricosa (Ehrenberg) Meister	Stoermer & Kreis 1978
Caloneis ventricosa var. alpina Patrick	Collins & Kalinsky 1977
Caloneis ventricosa var. inflata	Collins & Kalinsky 1977
Caloneis ventricosa var. minuta (Grunow) Patrick	Stoermer & Kreis 1978
Caloneis ventricosa var. truncatula (Grunow) Meister	Stoermer & Kreis 1978
Caloneis ventricosa var. subundulata (Grunow) Patrick	Patrick & Reimer 1966
Caloneis westii (W. Smith) Hendey	Kaczmarska & Rushforth 1983
Caloneis zachariasii Reichelt	Prescott & Dillard 1979
Campylodiscus alaetus Setty	Rushforth & Merkley 1988
Campylodiscus american	Ehrenberg 1856
Campylodiscus bicostatus W. Smith	Elmore 1922
Campylodiscus clypeus Ehrenberg	Stoermer et al. 1999
Campylodiscus costatus W. Smith	Tempère & Peragallo 1909
Campylodiscus cribrosus W. Smith	Stoermer & Kreis 1978
Campylodiscus decorus Brébisson	Stoermer & Kreis 1978
Campylodiscus echensis Ehrenberg	Stoermer et al. 1999
Campylodiscus ehrenbergii Ralfs	Rushforth & Merkley 1988
Campylodiscus eiowanus	Ehrenberg 1856
Campylodiscus hibernicus Ehrenberg	Stoermer & Kreis 1978
Campylodiscus noricus Ehrenberg	Stoermer & Kreis 1978
Campylodiscus noricus var. hibernica (Ehrenberg) Grunow	Stoermer & Kreis 1978
Campylodiscus spiralis	Myers 1898
Capartogramma crucicula (Grunow) Ross	Stoermer & Kreis 1978

Name	Publication
Catacombus gaillonii (Bory) Williams & Round	Stoermer et al. 1999
Cavinula cocconeiformis (Gregory ex Greville) D.G. Mann & Stickle in Round et al.	Stoermer et al. 1999
Cavinula intractata (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Cavinula jaernefeltii (Hustedt) D.G. Mann & Stickle in Round et al.	Stoermer et al. 1999
Cavinula lacustris (Gregory) D.G. Mann & Stickle in Round et al.	Stoermer et al. 1999
Cavinula pseudoscutiformis (Hustedt) D.G. Mann & Stickle in Round et al.	Stoermer et al. 1999
Cavinula scutelloides (W. Smith) Lange-Bertalot	Stoermer et al. 1999
Cavinula scutiformis (Grunow ex A. Schmidt) D.G. Mann & Stickle in Round et al.	Stoermer et al. 1999
Cavinula variostriata (Krasske) D.G. Mann & Stickle in Round et al.	Stoermer et al. 1999
Ceratoneis arcus Kützing	Stoermer & Kreis 1978
Ceratoneis arcus var. amphioxys (Rabenhorst) Grunow	Stoermer & Kreis 1978
Ceratoneis fasciolata	Ehrenberg 1856
Chamaepinnularia begeri (Krasske) Lange-Bertalot	Stoermer et al. 1999
Chamaepinnularia bremensis (Hustedt) Lange-Bertalot in Lange-Bertalot & Metzeltin	Siver et al. 2005
Chamaepinnularia evanida Lange-Bertalot	Stoermer et al. 1999
Chamaepinnularia margaritacea (Hustedt) Lange-Bertalot	Johansen et al. 2004
Chamaepinnularia mediocris (Krasske) Lange-Bertalot	Stoermer et al. 1999
Chamaepinnularia soehrensis (Krasske) Lange-Bertalot	Stoermer et al. 1999
Chamaepinnularia soehrensis var. hassiaca (Krasske) Lange-Bertalot	Johansen et al. 2004
Chaetoceras amanita A. Cleve	Kaczmarska & Rushforth 1983
Chaetoceras elmorei Boyer	Boyer 1927a
Chaetoceros hohnii Graebner & Wujek	Stoermer et al. 1999
Chaetoceros muelleri Lemmermann	Kociolek & Herbst 1992
Chaetoceros muelleri var. subsalsum (Lemmermann) Johansen & Rushforth	Rushforth & Johansen 1986
Cocconeis americana	Ehrenberg 1856
Cocconeis amygdalina (Brébisson) Grunow	Patrick & Reimer 1966
Cocconeis borealis	Ehrenberg 1856
Cocconeis decussata	Ehrenberg 1856
Cocconeis delalineata Hohn	Patrick & Reimer 1966
Cocconeis delapunctata Hohn	Patrick & Reimer 1966
Cocconeis diminuta Pantocsek	Stoermer & Kreis 1978
Cocconeis diminuta var. aegagropilae Murobase	Stoermer et al. 1999
Cocconeis diruptoides Hustedt	Stoermer & Kreis 1978
Coccoensi distans Gregory	Patrick & Reimer 1966
Cocconeis disculus (Schumann) Cleve	Stoermer & Kreis 1978
Cocconeis disculus var. diminuta (Pantocsek) A. Cleve	Stoermer & Kreis 1978
Cocconeis elongata	Ehrenberg 1856
Cocconeis euglypta Ehrenberg	Ehrenberg 1856
Cocconeis finnica Ehrenberg	Rushforth & Merkley 1988
Cocconeis flexella (Kützing) Cleve	Stoermer & Kreis 1978
Cocconeis fluviatilis Wallace	Stoermer & Kreis 1978
Cocconeis inusitatus Hohn	Patrick & Reimer 1966
Cocconeis japonica A. Schmidt	Rushforth & Squires 1985
Cocconeis klamathensis Sovereign	Sovereign 1958
Cocconeis limbata Ehrenberg	Patrick & Reimer 1966
Cocconeis lineata Ehrenberg	Stoermer & Kreis 1978
Cocconeis mexicana Ehrenberg	Ehrenberg 1856
Cocconeis mexicana	Ehrenberg 1856
Cocconeis mormonorum Ehrenberg	Patrick & Reimer 1966
Cocconeis neodiminuta Krammer	Stoermer et al. 1999
Cocconeis oblonga Kützing	Patrick & Reimer 1966
Cocconeis patrickiae Reimer	Patrick & Reimer 1966

Name	Publication
Cocconeis pellucida Hantzsch	Patrick & Reimer 1966
Cocconeis pediculus Ehrenberg	Stoermer & Kreis 1978
Cocconeis pinnata Gregory	Patrick & Reimer 1966
Cocconeis placentula Ehrenberg	Stoermer & Kreis 1978
Cocconeis placentula var. euglypta (Ehrenberg) Cleve	Stoermer & Kreis 1978
Cocconeis placentula var. intermedia (Héribaud & Peragallo) Cleve	Collins & Kalinsky 1977
Cocconeis placentula var. klinoraphis Geitler	Stoermer et al. 1999
Cocconeis placentula var. lineata (Ehrenberg) Van Heurck	Stoermer & Kreis 1978
Cocconeis placentula var. rouxii (Héribaud & Brun) Cleve	Stoermer et al. 1999
Cocconeis praetexta Ehrenberg	Patrick & Reimer 1966
Cocconeis rouxii Héribaud & Brun	Stoermer & Kreis 1978
Cocconeis rhombea Ehrenberg	Stoermer & Kreis 1978
Cocconeis rugosa Sovereign	Patrick & Reimer 1966
Cocconeis scutellum Ehrenberg	Stoermer & Kreis 1978
Cocconeis scutellum var. japonica (A. Schmidt) Skvortzow	Stoermer et al. 1999
Cocconeis scutellum var. parva Grunow	Stoermer & Kreis 1978
Cocconeis scutellum f. parva Grunow in Van Heurck	Patrick & Reimer 1966
Cocconeis silicula (Ehrenberg) Cleve	Kutkuhn 1958
Cocconeis striata	Ehrenberg 1856
Cocconeis thumensis A. Mayer	Stoermer & Kreis 1978
Cocconeis thwaitesii W. Smith	Stoermer & Kreis 1978
Cocconeis transversalis Gregory	Stoermer & Kreis 1978
Cocconeis turgida	Ehrenberg 1856
Cocconeis undulata Ehrenberg	Patrick & Reimer 1966
Cocconema arcus Ehrenberg	Patrick & Reimer 1975
Cocconema asperum	Ehrenberg 1856
Cocconema australicum A. Schmidt	Patrick & Reimer 1975
Cocconema cistula Hemprich	Stoermer & Kreis 1978
Cocconema cistula Ehrenberg	Cleve & Möller 1878
Cocconema cornutum Ehrenberg	Patrick & Reimer 1975
Cocconema cymbiforme (Kützing) Ehrenberg	Rushforth & Squires 1985
Cocconema eurypterum	Ehrenberg 1856
Cocconema excisum Kützing	H.L. Smith 1876–1888 (#81)
Cocconema fusidium Ehrenberg	Stoermer & Kreis 1978
Cocconema gastroides (Kützing) Pell.	Stoermer & Kreis 1978
Cocconema gibbum Ehrenberg	Patrick & Reimer 1975
Cocconema gloeonema	Ehrenberg 1856
Cocconema gracile	Ehrenberg 1856
Cocconema helveticum (Kützing) Grunow	Patrick & Reimer 1975
Cocconema lanceolatum Ehrenberg	Stoermer & Kreis 1978
Cocconema lunula	Ehrenberg 1856
Cocconema mexicana	Ehrenberg 1856
Cocconema parva W. Smith	Stoermer & Kreis 1978
Cocconema scotica W. Wmith	Stoermer & Kreis 1978
Cocconema subtile	Ehrenberg 1856
Collectonema lacustre Van Heurck	Stoermer & Kreis 1978
Collectonema minutum	Collins & Kalinsky 1977
Collectonema vulgare Thwaites	Collins & Kalinsky 1977
Coscinodiscus apiculatus Ehrenberg	Rushforth & Merkley 1988
Coscinodiscus argus Ehrenberg	Rushforth & Merkley 1988
Coscinodiscus asteromorphus Ehrenberg	Stoermer & Kreis 1978
Coscinodiscus bodanica Schneider	Prescott & Dillard 1979
Coscinodiscus catenata Brunnthaler	Prescott & Dillard 1979
Coscinodiscus chambonis M. Peragallo & Héribaud	Tempère & Peragallo 1909

Name	Publication
Coscinodiscus curvatalus Grunow	Stoermer & Kreis 1978
Coscinodiscus decrescens Grunow	Stoermer & Kreis 1978
Coscinodiscus denarius A. Schmidt	Czarnecki & Blinn 1978
Coscinodiscus lacustris Grunow	Stoermer & Kreis 1978
Coscinodiscus lanceolatum Ehrenberg	Stoermer & Kreis 1978
Coscinodiscus marginatus Ehrenberg	Stoermer & Kreis 1978
Coscinodiscus odontodiscus Grunow	Rushforth & Merkley 1988
Coscinodiscus pygmaeus var. micropunctatus M. Peragallo & Héribaud	Drum 1981
Coscinodiscus radiatus Ehrenberg	Stoermer & Kreis 1978
Coscinodiscus rothii (Ehrenberg) Grunow	Stoermer & Kreis 1978
Coscinodiscus rothii var. subsalsa (Juhl.-Dannf.) Hustedt	Stoermer & Kreis 1978
Coscinodiscus subsalsa Juhl.-Dannf.	Stoermer & Kreis 1978
Coscinodiscus subtilis Ehrenberg	Camburn 1982
Coscinodiscus subtilis var. radiatus Hohn	Hohn 1952
Coscinodiscus tuberculatus Greville	Stoermer & Kreis 1978
Coscinodiscus woodwardii	Tilden 1894–1909 (#367)
Cosmioneis lundstroemii (Cleve in Cleve & Grunow) D.G. Mann in Round et al.	Stoermer et al. 1999
Cosmioneis pusilla (W. Smith) D.G. Mann in Round et al.	Stoermer et al. 1999
Craspedodiscus coscinodiscus Ehrenberg	Stoermer et al. 1999
Craspedodiscus microdiscus Ehrenberg	Stoermer & Kreis 1978
Craticula accomoda (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Craticula acidoclinata Lange-Bertalot & Metzeltin	Siver et al. 2005
Craticula ambigua (Ehrenberg) D.G. Mann in Round et al.	Stoermer et al. 1999
Craticula citrus (Krasske) Reichardt	Potapova & Charles 2003
Craticula cuspidata (Kützing) D.G. Mann in Round et al.	Stoermer et al. 1999
Craticula cuspidata var. major (Meister) Czarnecki	Stoermer et al. 1999
Craticula halophilioides (Hustedt) Lange-Bertalot	Siver et al. 2005
Craticula perrotettii Grunow	Lange-Bertalot 2001
Craticula subhalophila (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Craticula vixvisibilis (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Ctenophora pulchella (Ralfs ex Kützing) Williams & Round	Stoermer et al. 1999
Ctenophora pulchella var. lacerata	Stoermer et al. 1999
Ctenophora pulchella var. lanceolata (O'Meara) Bukhtiyarova	Stoermer et al. 1999
Cyclostephanos costalimbus (Kob. & Kob.) Stoermer Håkansson & Theriot	Stoermer et al. 1999
Cyclostephanos delicatus (Genkal) Kling & Håkansson	Håkansson & Kling 1990
Cyclostephanos dubius (Fricke) Round in Theriot et al.	Stoermer et al. 1999
Cyclostephanos invisitatus (Hohn & Hellerman) Theriot Stoermer & Håkansson	Stoermer et al. 1999
Cyclostephanos tholiformis Stoermer et al.	Håkansson & Kling 1990
Cyclotella aliquantula Hohn & Hellerman	Hohn & Hellerman 1963
Cyclotella americana Fricke	Stoermer et al. 1999
Cyclotella antiqua W. Smith	Stoermer & Kreis 1978
Cyclotella arentii Kolbe	Hamilton et al. 1992
Cyclotella atomus Hustedt	Stoermer & Kreis 1978
Cyclotella berolinensis Ehrenberg	Tilden1894–1909 (#367)
Cyclotella bodanica Eulenstein	Stoermer & Kreis 1978
Cyclotella bodanica var. lemanensis O. Müller	Clark & Rushforth 1977
Cyclotella bodanica var. michiganensis Skvortzow 1937	Stoermer & Kreis 1978
Cyclotella bodanica var. stellata Skvortzow 1937	Stoermer & Kreis 1978
Cyclotella caspia Grunow	Stoermer & Kreis 1978
Cyclotella catenata Brun	Stoermer & Kreis 1978
Cyclotella chaetoceras Lemmermann	Stoermer & Kreis 1978

Name	Publication
Cyclotella choctawhatcheeana Prasad	Carvallo et al. 1995
Cyclotella comensis Grunow	Stoermer & Kreis 1978
Cyclotella comta (Ehrenberg) Kützing	Stoermer & Kreis 1978
Cyclotella comta var. bodanica Grunow	Stoermer & Kreis 1978
Cyclotella comta var. glabriuscula Grunow	Stoermer & Kreis 1978
Cyclotella comta var. oligactis (Ehrenberg) Grunow	Stoermer & Kreis 1978
Cyclotella comta var. paucipunctata Grunow	Stoermer & Kreis 1978
Cyclotella comta var. radiosa Grunow	Patrick 1945
Cyclotella cryptica Reimann et al.	Stoermer & Kreis 1978
Cyclotella cyclopunctata Håkansson & Carter	Stoermer et al. 1999
Cyclotella delicatula Hustedt	Stoermer et al. 1999
Cyclotella distinguenda Hustedt	Stoermer et al. 1999
Cyclotella distinguenda var. unipunctata (Hustedt) Håkansson	Stoermer et al. 1999
Cyclotella dubia Hilse	Stoermer & Kreis 1978
Cyclotella facetia Hohn & Hellerman	Stoermer & Kreis 1978
Cyclotella florida Voigt	Patrick 1968
Cyclotella gamma Sovereign	Sovereign 1963
Cyclotella glomerata Bachmann	Stoermer & Kreis 1978
Cyclotella krammeri Håkansson	Stoermer et al. 1999
Cyclotella kuetzingiana Thwaites	Stoermer & Kreis 1978
Cyclotella kuetzingiana var. planetophora Fricke	Stoermer & Kreis 1978
Cyclotella kuetzingiana var. radiosa Fricke	Stoermer & Kreis 1978
Cyclotella kuetzingiana var. schumannii Grunow	Gaufin et al. 1976
Cyclotella melosiroides (Kirchner) Lemmermann	Stoermer & Kreis 1978
Cyclotella meneghiniana Kützing	Stoermer & Kreis 1978
Cyclotella meneghiniana var. plana Fricke	Stoermer & Kreis 1978
Cyclotella meneghiniana var. pumila (Grunow ex Van Heurck) Hustedt	Grimes & Rushforth 1982
Cyclotella meneghiniana var. rectangulata	Patrick 1945
Cyclotella meneghiniana var. stelligera Cleve & Grunow in Cleve	Boyer 1927a
Cyclotella meneghiniana var. stellulifera Cleve & Grunow	Stoermer & Kreis 1978
Cyclotella michiganiana Skvortzow 1937	Stoermer & Kreis 1978
Cyclotella minutula Arnott	H.L. Smith1876–1888 (#107)
Cyclotella nana Hustedt	Stoermer & Kreis 1978
Cyclotella ocellata Pantocsek	Stoermer & Kreis 1978
Cyclotella operculata (Agardh) Kützing	Stoermer & Kreis 1978
Cyclotella operculata W. Smith	H.L. Smith 1876–1888 (#107)
Cyclotella operculata var. unipunctata (Fricke) Hustedt	Stoermer et al. 1999
Cyclotella oregonica H.L. Smith	H.L. Smith 1876–1888 (#504)
Cyclotella perforata M. Peragallo	Tempère & Peragallo 1909
Cyclotella planktonica Brunnthaler	Stoermer & Kreis 1978
Cyclotella pseudostelligera Hustedt	Stoermer & Kreis 1978
Cyclotella pseudosteolligera f. parva Czarnecki & Blinn	Czarnecki 1979
Cyclotella quadriiunta (Schroeter) Hustedt	Stoermer & Kreis 1978
Cyclotella radiosa Grunow	Stoermer et al. 1999
Cyclotella rossii Håkansson	Stoermer et al. 1999
Cyclotella rotula Kützing	Stoermer & Kreis 1978
Cyclotella seratula Hohn & Hellerman	Hohn & Hellerman 1963
Cyclotella socialis Schutt	Stoermer et al. 1999
Cyclotella spinosa Schumann	Stoermer & Kreis 1978
Cyclotella stelligera (Cleve & Grunow) Van Heurck	Stoermer & Kreis 1978
Cyclotella stelligera var. tenuis Hustedt	Dodd 1987
Cyclotella striata (Kützing) Grunow	Stoermer & Kreis 1978
Cyclotella striata var. ambigua Grunow	Collins & Kalinsky 1977
Cyclotella striata var. bipunctata Fricke	Stoermer & Kreis 1978
Cyclotella striata var. mesoleia	Tempère & Peragallo 1913
Cyclotella temperei M. Peragallo & Héribaud	Stoermer & Kreis 1978
Cyclotella terryana Tempère & Peragallo	Tempère & Peragallo 1909

Name	Publication
Cyclotella thienemannii var. minuscula Jurilj	Stoermer et al. 1999
Cyclotella woltereckii Hustedt	Stoermer & Kreis 1978
Cyclotubicoalistus undatus Stoermer et al.	Stoermer et al. 1990
Cylindrotheca gracilis (Brébisson ex Kützing) Grunow	Camburn 1982
Cymatopleura angulata Greville	Stoermer & Kreis 1978
Cymatopleura apiculata W. Smith	Stoermer & Kreis 1978
Cymatopleura campylodiscus J.W. Bailey	H.L. Smith 1876–1888 (#641)
Cymatopleura cochlea Brun	Stoermer & Kreis 1978
Cymatopleura elliptica (Brébisson & Godey) W. Smith	Stoermer & Kreis 1978
Cymatopleura elliptica var. constricta Grunow	Rushforth & Squires 1985
Cymatopleura elliptica var. hibernica (W. Smith) Van Heurck	Stoermer & Kreis 1978
Cymatopleura elliptica var. nobilis (Hantzsch) Hustedt	Dodd 1987
Cymatopleura elliptica f. spiralis Boyer	Stoermer & Kreis 1978
Cymatopleura hibernica W. Smith	Stoermer & Kreis 1978
Cymatopleura hibernica var. rhombica H.H. Chase	Stoermer & Kreis 1978
Cymatopleura librile (Ehrenberg) Pantocsek	Camburn 1982
Cymatopleura mannii M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1909
Cymatopleura solea (Brébisson & Godey) W. Smith	Stoermer & Kreis 1978
Cymatopleura solea var. apiculata (W. Smith) Ralfs	Stoermer & Kreis 1978
Cymatopleura solea var. clavata O. Müller	Stoermer & Kreis 1978
Cymatopleura solea var. gracilis Grunow	Stoermer et al. 1999
Cymatopleura solea var. palffyi (Pantocsek) Cleve-Euler	Rushforth & Squires 1985
Cymatopleura solea var. pfuhlii Torka	Stoermer & Kreis 1978
Cymatopleura solea var. regula (Ehrenberg) Grunow	Stoermer & Kreis 1978
Cymatopleura solea var. subconstricta O. Müller	Stoermer et al. 1999
Cymatopleura solea var. vulgaris Meister	Tiffany & Britton 1952
Cymatopleura spiralis H.H. Chase	Stoermer & Kreis 1978
Cymbella acuta (A. Schmidt) Cleve	Patrick & Reimer 1975
Cymbella acutiuscula Cleve	Stoermer & Kreis 1978
Cymbella aequalis W. Smith	Stoermer & Kreis 1978
Cymbella aequalis var. subaequalis Grunow	Collins & Kalinsky 1977
Cymbella affinis Kützing	Stoermer & Kreis 1978
Cymbella alpestris Krammer	Krammer 2002
Cymbella americana A.Schmidt	Tempère & Peragallo 1908
Cymbella americana f. minor	Van Heurck & Grunow 1882–1885 (#138)
Cymbella amphicephala Nageli	Stoermer & Kreis 1978
Cymbella amphicephala var. subundulata Cleve	Stoermer & Kreis 1978
Cymbella amphioxys (Kützing) Cleve	Bateman & Rushforth 1984
Cymbella anglica Lagerstedt	Stoermer & Kreis 1978
Cymbella angustata (W. Smith) Cleve	Stoermer & Kreis 1978
Cymbella aspera (Ehrenberg) H. Peragallo	Stoermer & Kreis 1978
Cymbella aspera var. minor (Van Heurck) Cleve	Stoermer & Kreis 1978
Cymbella australica (A. Schmidt) Conger	Hohn 1951
Cymbella austriaca Grunow	Stoermer & Kreis 1978
Cymbella bonnevillensis Setty	Rushforth & Merkley 1988
Cymbella borealis Cleve	Camburn & Charles 2000
Cymbella brehmii Hustedt	Stoermer & Kreis 1978
Cymbella buechleri Krammer	Krammer 2002
Cymbella caespitosa Brun	Stoermer & Kreis 1978
Cymbella caespitosum Kützing	Aubert 1895
Cymbella capitata M. Peragallo	Patrick & Reimer 1975
Cymbella cesatii (Rabenhorst) Grunow	Stoermer & Kreis 1978
Cymbella cesati var. linearis Reimer	Reimer 1961

Name	Publication
Cymbella cistula (Ehrenberg) Kirchner	Stoermer & Kreis 1978
Cymbella cistula var. crassa Tempère & Peragallo	Tempère & Peragallo 1909
Cymbella cistula var. fusidium	Tempère & Peragallo 1909
Cymbella cistula var. gibbosa Brun	Stoermer & Kreis 1978
Cymbella cistula var. gracilis Hustedt	Patrick & Reimer 1975
Cymbella cistula var. maculata (Kützing) Van Heurck	Stoermer & Kreis 1978
Cymbella cistula var. truncata Brun	Stoermer & Kreis 1978
Cymbella clausii Van Landingham	Camburn 1982
Cymbella couleensis Sovereign	Sovereign 1963
Cymbella cucumis var. delicata Tempère & Peragallo	Tempère & Peragallo 1909
Cymbella curta A. Schmidt	Boyer 1927b
Cymbella cuspidata Kützing	Stoermer & Kreis 1978
Cymbella cuspidata var. lanceolata May	Clark & Rushforth 1977
Cymbella cuspidata var. schulzii A. Cleve	Stoermer & Kreis 1978
Cymbella cuspidata f. impressa Fusey	Stoermer et al. 1999
Cymbella cymbiformis Agardh	Stoermer & Kreis 1978
Cymbella cymbiformis var. nonpunctata Fontell	Collins & Kalinsky 1977
Cymbella cymbiformis var. parra (W. Smith) Van Heurck	Myers 1898b
Cymbella delicatula Kützing	Stoermer & Kreis 1978
Cymbella delicatula var. intermedia McCall	Patrick & Reimer 1975
Cymbella descripta (Hustedt) Krammer	Camburn & Charles 2000
Cymbella designata Krammer	Stoermer et al. 1999
Cymbella diluviana (Krasske) Florin	Stoermer & Kreis 1978
Cymbella dissimilis M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1909
Cymbella dorsirostrata Krammer	Krammer 2002
Cymbella duplopunctata Krammer	Krammer 2002
Cymbella ehrenbergii Kützing	Stoermer & Kreis 1978
Cymbella ehrenbergii var. hungarica Pantocsek	Clark & Rushforth 1977
Cymbella ehrenbergii var. minor	Tempère & Peragallo 1909
Cymbella elizabethana Krammer	Krammer 2002
Cymbella elginsis Krammer	Stoermer et al. 1999
Cymbella excisa Kützing	Boyer 1927b
Cymbella fluminea Patrick & Freese	Patrick & Reimer 1975
Cymbella fonticola Hstedt	Collins & Kalinsky 1977
Cymbella formosa Hustedt	Hustedt 1955
Cymbella gastroides Kützing	Stoermer & Kreis 1978
Cymbella gasteroides (Kützing) Kützing	Rushforth & Merkley 1988
Cymbella gerloffii Van Landingham	Camburn 1982
Cymbella gibba J.W. Bailey	Patrick & Reimer 1975
Cymbella gibberula Hustedt	Krammer 2002
Cymbella gracilis (Rabenhorst) Cleve	Stoermer & Kreis 1978
Cymbella gracilis var. lunata W. Smith	Whitford & Schumacher 1973
Cymbella hauckii Van Heurck	Stoermer & Kreis 1978
Cymbella hebridica Grunow ex Cleve	Stoermer & Kreis 1978
Cymbella helvetica Kützing	Stoermer & Kreis 1978
Cymbella heteropleura (Ehrenberg) Kützing	Boyer 1927b
Cymbella heteropleura var. minor Cleve	Clark & Rushforth 1977
Cymbella heteropleura var. subrostrata Cleve	Patrick & Reimer 1975
Cymbella heteropleura var. symmetrica Boyer	Boyer 1927b
Cymbella hohnii Van Landingham	Camburn 1982
Cymbella hungarica var. grunowii A. Cleve	Clark & Rushforth 1977
Cymbella hustedtii Krasske	Stoermer & Kreis 1978
Cymbella hybrida Grunow	Stoermer & Kreis 1978
Cymbella hybridiformis Hustedt	Patrick & Reimer 1975
Cymbella inaequalis (Ehrenberg) Rabenhorst	Stoermer & Kreis 1978
Cymbella incerta (Grunow) Cleve	Stoermer & Kreis 1978
Cymbella incerta var. naviculacea Grunow	Johansen et al. 1983

Name	Publication
Cymbella inelegans Cleve	Patrick & Reimer 1975
Cymbella janischii A. Schmidt	Boyer 1927b
Cymbella javanica Hustedt	Camburn 1982
Cymbella jordani Grunow	Stoermer & Kreis 1978
Cymbella kappii Cholnoky	Dodd 1987
Cymbella lacustris (Agardh) Cleve	Boyer 1927b
Cymbella laevis Nageli	Stoermer & Kreis 1978
Cymbella lanceolata (Agardh) Agardh	Stoermer & Kreis 1978
Cymbella lanceolata var. cornuta (Ehrenberg) Grunow	Krammer 2002
Cymbella lanceolatum Ehrenberg	Aubert 1895
Cymbella langii MacLaughlin & Andrews	Krammer 2002
Cymbella lata Grunow	Stoermer & Kreis 1978
Cymbella latens Krasske	Stoermer & Kreis 1978
Cymbella laubyi M. Peragallo & Héribaud	Tempère & Peragallo 1912
Cymbella leptoceros (Ehrenberg) Rabenhorst	Stoermer & Kreis 1978
Cymbella leptoceros var. angusta Grunow	Boyer 1927b
Cymbella leptoceros var. rostrata Hustedt	Stoermer & Kreis 1978
Cymbella lunata W. Smith	Camburn 1982
Cymbella maculata Kützing	Stoermer & Kreis 1978
Cymbella mexicana (Ehrenberg) Cleve	Stoermer & Kreis 1978
Cymbella mexicana var. janischii (A. Schmidt) Reimer	Patrick & Reimer 1975
Cymbella mexicana var. punctifera Krammer	Krammer 2002
Cymbella microcephala Grunow	Stoermer & Kreis 1978
Cymbella microcephala var. crassa Reimer	Stoermer et al. 1999
Cymbella minuta Hilse	Stoermer & Kreis 1978
Cymbella minuta var. pseudogracilis (Cholnoky) Reimer	Stoermer & Kreis 1978
Cymbella minuta var. silesiaca (Bleisch) Reimer	Stoermer & Kreis 1978
Cymbella minuta f. latens (Krasske) Reimer	Stoermer & Kreis 1978
Cymbella moelleriana Grunow	Stoermer & Kreis 1978
Cymbella muelleri Hustedt	Stoermer & Kreis 1978
Cymbella muelleri f. ventricosa (Tempère & Peragallo) Reimer	Stoermer & Kreis 1978
Cymbella naviculiformis Auerswald	Stoermer & Kreis 1978
Cymbella norvegica Grunow	Stoermer & Kreis 1978
Cymbella norvegica f. minor Fusey	Patrick & Reimer 1975
Cymbella obtusa Gregory	Stoermer & Kreis 1978
Cymbella obtusa f. krasskei Foged	Reimer 1961
Cymbella obtusiuscula Kützing	Stoermer & Kreis 1978
Cymbella ornata Hustedt	Hustedt 1931
Cymbella para (W. Smith) Wolle	Benson & Rushforth 1975
Cymbella parva (W. Smith) Cleve	Stoermer & Kreis 1978
Cymbella parvula Krasske	Stoermer & Kreis 1978
Cymbella pediculus Kützing	Stoermer & Kreis 1978
Cymbella perfossilis Krammer	Krammer 2002
Cymbella perpusilla A. Cleve	Camburn 1982
Cymbella philadelphica Boyer	Boyer 1927b
Cymbella procera Hustedt	Hustedt 1931
Cymbella producta M. Peragallo	Tempère & Peragallo 1908
Cymbella prostrata (Berkeley) Cleve	Stoermer & Kreis 1978
Cymbella prostrata var. auerswaldii (Rabenhorst) Reimer	Stoermer & Kreis 1978
Cymbella protracta Østrup	Rushforth & Squires 1985
Cymbella proxima Reimer	Stoermer & Kreis 1978
Cymbella proxima f. gravida Reimer	Patrick & Reimer 1975
Cymbella pusilla Grunow	Stoermer & Kreis 1978
Cymbella rabenhorstii R. Ross	Stoermer et al. 1999
Cymbella rainierensis Sovereign	Patrick & Reimer 1975
Cymbella reinhardtii Grunow	Patrick & Reimer 1975
Cymbella rhomboidea Boyer	Stoermer & Kreis 1978

Name	Publication
Cymbella robertii Krammer	Krammer 2002
Cymbella rotundata H.H. Chase	Stoermer & Kreis 1978
Cymbella rugosa Hustedt	Stoermer & Kreis 1978
Cymbella rupicola Grunow	Collins & Kalinsky 1977
Cymbella ruttneri Hustedt	Stoermer & Kreis 1978
Cymbella ruttneri var. obtusa Hustedt	Camburn 1982
Cymbella schubartoides Camburn & Charles	Camburn & Charles 2000
Cymbella schmidtii Grunow	Collins & Kalinsky 1977
Cymbella scotica W. Smith	Patrick 1945
Cymbella silesiaca Bleisch	Yearsley et al. 1992
Cymbella similis Krasske	Stoermer & Kreis 1978
Cymbella sinuata Gregory	Stoermer & Kreis 1978
Cymbella sinuata var. antiqua (Grunow) Cleve	Stoermer & Kreis 1978
Cymbella sinuata var. ovata Hustedt	Stoermer & Kreis 1978
Cymbella sinuata f. antiqua (Grunow) Reimer	Stoermer et al. 1999
Cymbella sinuata f. ovata (Hustedt) Hustedt	Stoermer & Kreis 1978
Cymbella stauroneiformis Lagestedt	Boyer 1927b
Cymbella stodderi Cleve	Boyer 1927b
Cymbella stomatophora Grunow	Stoermer & Kreis 1978
Cymbella subaequalis Grunow	Stoermer & Kreis 1978
Cymbella subaequalis f. krasskei (Foged) Reimer	Stoermer et al. 1999
Cymbella subaspera var. salina Krammer	Krammer 2002
Cymbella subcistula Krammer	Siver et al. 2005
Cymbella subventricosa Cholnoky	Stoermer & Kreis 1978
Cymbella thumensis (A. Mayer) Hustedt	Patrick & Reimer 1975
Cymbella triangulum (Ehrenberg) Cleve	Stoermer & Kreis 1978
Cymbella tumida (Brébisson) Van Heurck	Stoermer & Kreis 1978
Cymbella tumida var. borealis (Grunow) Cleve	Patrick & Reimer 1975
Cymbella tumidula Grunow	Stoermer & Kreis 1978
Cymbella turgida Gregory	Stoermer & Kreis 1978
Cymbella turgida var. pseudogracilis Cholnoky	Stoermer & Kreis 1978
Cymbella turgidula Grunow	Stoermer & Kreis 1978
Cymbella ventricosa Agardh	Stoermer & Kreis 1978
Cymbella ventricosa var. auerswaldii Meister	Hohn & Hellerman 1963
Cymbella ventricosa var. girodi (Héribaud) H. Kobayashi	Patrick & Reimer 1975
Cymbella ventricosa var. ovata f. minor Cleve-Euler	Patrick & Reimer 1975
Cymbella ventricosa var. silesiaca (Bleisch) Cleve	Prescott & Dillard 1979
Cymbellonitzschia diluviana Hustedt	Stoermer & Kreis 1978
Cymbopleura acutiuscula (Cleve) Krammer	Krammer 2003
Cymbopleura lata var. americana Krammer	Krammer 2003
Cymbopleura oregonica (Cleve) Krammer	Krammer 2003
Cymbopleura oregonica var. lata Krammer	Krammer 2003
Cymbopleura ornata (Hustedt) Krammer	Krammer 2003
Cymbopleura peroregonica Krammer	Krammer 2003
Cymbopleura procera (Hustedt) Krammer	Krammer 2003
Cymbopleura subrostrata (Cleve) Krammer	Krammer 2003
Cystopleura argus (Kützing) Kuntze	Elmore 1922
Cystopleura gibba (Ehrenberg) Kuntze	Stoermer & Kreis 1978
Cystopleura gibberula (Kützing) Kuntze	Elmore 1922
Cystopleura musculus (Kützing) Kuntze	Elmore 1922
Cystopleura musculus var. constricta (Brébisson) Van Heurck	
Cystopleura ocellata (Ehrenberg) Kuntze	Elmore 1922
Cystopleura sorex (Kützing) Kuntze	Tilden 1894–1909 (#99)
Cystopleura turgida (Ehrenberg) Kuntze	Stoermer & Kreis 1978

Name	Publication
Cystopleura ventricosa (Kützing) Elmore	Elmore 1922
Cystopleura zebra (Ehrenberg) Kuntze	Elmore 1922
Cystopleura zebra var. proboscidea (Kützing) De Toni	Patrick 1945
Cystopleura zebra var. saxonica (Kützing) De Toni	Patrick 1945
Decussata placenta (Ehrenberg) Lange-Bertalot in Metzeltin & Lange-Bertalot	Johansen et al. 2004
Delicata gerloffii (Van Landingham) Krammer	Krammer 2003
Denticula elegans Kützing	Stoermer & Kreis 1978
Denticula elegans var. kittoniana (Grunow) DeToni	Patrick & Reimer 1975
Denticula elegans f. valida Pedicino	Patrick & Reimer 1975
Denticula frigida Kützing	Stoermer & Kreis 1978
Denticula kutzingii Grunow	Camburn & Charles 2000
Denticula lauta J.W. Bailey	Stoermer & Kreis 1978
Denticula palea	Tilden 1894–1909 (#253)
Denticula rainierensis Sovereign	Patrick & Reimer 1975
Denticula splendens	Patrick & Reimer 1975
Denticula subtilis Grunow	Rushforth & Squires 1985
Denticula tenuis Kützing	Stoermer & Kreis 1978
Denticula tenuis var. crassula (Nageli) W. & G.S. West	Stoermer & Kreis 1978
Denticula tenuis f. diminuta Manguin	Dodd 1987
Denticula tenuis var. frigida (Kützing) Grunow	Stoermer & Kreis 1978
Denticula thermalis Kützing	Stoermer & Kreis 1978
Denticula valida (Pedicino) Grunow in Van Heurck	Tempère & Peragallo 1913
Desmogonium guianense Ehrenberg	Patrick 1946
Desmogonium rabenhorstianum var. elongatum Patrick	Whitford & Schumacher 1973
Diadesmis confervacea Kützing	Stoermer et al. 1999
Diadesmis contenta (Grunow ex Van Heurck) D.G. Mann in Round et al.	Stoermer et al. 1999
Diadesmis contenta var. biceps (Grunow in Van Heurck) Hamilton in Hamilton et al.	Hamilton et al. 1992
Diadesmis gallica var. nitzschioides Grunow	Cleve & Möller 1879
Diadesmis peregrina W. Smith	Stoermer et al. 1999
Diadesmis perpusilla (Grunow) D.G. Mann in Round et al.	Stoermer et al. 1999
Diatoma anceps (Ehrenberg) Kirchner	Stoermer & Kreis 1978
Diatoma anceps var. capitatum Peragallo in Terry	Boyer 1927a
Diatoma anceps var. constricta Tempère & Peragallo	Tempère & Peragallo 1912
Diatoma anceps var. linearis M. Peragallo	Stoermer & Kreis 1978
Diatoma anceps var. mesodon (Ehrenberg) Grunow in Van Heurck	Hamilton et al. 1992
Diatoma ehrenbergii Kützing	Stoermer & Kreis 1978
Diatoma elongata Agardh	Stoermer & Kreis 1978
Diatoma elongatum (Lyngbye) Agardh	Stoermer & Kreis 1978
Diatoma elongatum var. minor Grunow	Stoermer & Kreis 1978
Diatoma elongatum var. tenue (Agardh) Van Heurck	Stoermer & Kreis 1978
Diatoma elongatum var. tenuis (Agardh) Van Heurck	Stoermer & Kreis 1978
Diatoma hiemale (Roth) Heiberg	Stoermer & Kreis 1978
Diatoma hiemale var. mesodon (Ehrenberg) Grunow	Stoermer & Kreis 1978
Diatoma hyemale f. curta	Patrick & Reimer 1966
Diatoma mesodon (Ehrenberg) Kützing	Hamilton et al. 1992
Diatoma moniliformis Kützing	Potapova & Charles 2002
Diatoma stellaris	Patrick & Reimer 1966
Diatoma stellata	Patrick & Reimer 1966
Diatoma tenue Agardh	Stoermer & Kreis 1978
Diatoma tenue var. elongatum Lyngbye	Stoermer & Kreis 1978
Diatoma tenue var. pachycephala Grunow	Stoermer & Kreis 1978

Name	Publication
Diatoma vulgare Bory	Stoermer & Kreis 1978
Diatoma vulgare var. breve Grunow	Patrick & Reimer 1966
Diatoma vulgare var. capitulatum Grunow in Van Heurck	Patrick & Reimer 1966
Diatoma vulgare var. ehrenbergii (Kützing) Grunow	Stoermer & Kreis 1978
Diatoma vulgare var. grande (W. Smith) Grunow	Stoermer & Kreis 1978
Diatoma vulgare var. ovalis (Fricke) Hustedt	Stoermer & Kreis 1978
Diatoma vulgare var. pachycephala Grunow	Gaufin 1976
Diatoma vulgare var. producta Grunow	Stoermer & Kreis 1978
Diatoma vulgare var. linearis Van Heurck	Stoermer & Kreis 1978
Diatomella balfouriana Greville	Camburn 1982
Didymosphenia geminata (Lyngbye) M. Schmidt	Stoermer & Kreis 1978
Diploneis boldtiana Cleve	Stoermer & Kreis 1978
Diploneis domblittensis Grunow	Stoermer & Kreis 1978
Diploneis elliptica (Kützing) Cleve	Stoermer & Kreis 1978
Diploneis elliptica var. ladogensis Cleve	Stoermer et al. 1999
Diploneis elliptica var. pygmaea A. Cleve	Stoermer & Kreis 1978
Diploneis finnica (Ehrenberg) Cleve	Stoermer & Kreis 1978
Diploneis fusca (Gregory) Cleve	Johansen et al. 2004
Diploneis fusca var. delicata (A. Schmidt) Cleve	Patrick & Reimer 1966
Diploneis interrupta (Kützing) Cleve	Stoermer & Kreis 1978
Diploneis marginestriata Hustedt	Stoermer & Kreis 1978
Diploneis oblongella (Nageli) Ross	Stoermer & Kreis 1978
Diploneis oblongella var. genuina Nageli	Stoermer & Kreis 1978
Diploneis ocellata Østrup	Stoermer et al. 1999
Diploneis oculata (Brébisson) Cleve	Stoermer & Kreis 1978
Diploneis oculata var. linearis Gallik	Prescott & Dillard 1979
Diploneis ostracodarum (Pantocsek) Jurilj	Patrick & Reimer 1966
Diploneis ovalis (Hilse) Cleve	Stoermer & Kreis 1978
Diploneis ovalis var. oblongella (Naegeli) Cleve	Hohn 1951
Diploneis papula (A. Schmidt) Cleve	Stoermer & Kreis 1978
Diploneis parma Cleve	Stoermer & Kreis 1978
Diploneis peterseni Hustedt	Stoermer & Kreis 1978
Diploneis pseudovalis Hustedt	Stoermer & Kreis 1978
Diploneis puella (Schumann) Cleve	Stoermer & Kreis 1978
Diploneis smithii (Brébisson) Cleve	Stoermer & Kreis 1978
Diploneis smithii var. dilatata (M. Peragallo) Boyer	Camburn 1982
Diploneis smithii var. pumila (Grunow) Hustedt	Stoermer & Kreis 1978
Diploneis smithii f. rhombica Mereschkowsky	Kaczmarska & Rushforth 1983
Diploneis subovalis Cleve	Stoermer & Kreis 1978
Distrionella incognita (Reichardt) Williams	Morales et al. 2005
Ellerbeckia arenaria (Moore ex Ralfs) R.M. Crawford	Stoermer et al. 1999
Encyonema auerswaldii Rabenhorst	Stoermer et al. 1999
Encyonema brehmii (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Encyonema caespitosum Kützing	Stoermer & Kreis 1978
Encyonema evergladianum Krammer	Krammer 1997b
Encyonema formosum (Hustedt) D.G. Mann	Krammer 1997a
Encyonema gaeumannii (Meister) Krammer	Siver et al. 2005
Encyonema gibbum (J.W. Bailey) Krammer	Krammer 1997a
Encyonema gracile Rabenhorst	Stoermer & Kreis 1978
Encyonema hebridicum Grunow ex Cleve	Krammer 1997b
Encyonema hohnii (Van Landingham) Krammer	Krammer 1997b

Name	Publication
Encyonema inelegans (Cleve) Mills	Krammer 1997a
Encyonema lacustre (C. Agardh) D.G. Mann in Round et al.	Stoermer et al. 1999
Encyonema latens (Krasske) D.G. Mann in Round et al.	Stoermer et al. 1999
Encyonema lunatum (W. Smith) Van Heurck	Krammer 1997a
Encyonema minutum (Hilse ex Rabenhorst) D.G. Mann in Round et al.	Stoermer et al. 1999
Encyonema minutum var. pseudogracilis (Cholnoky) Czarnecki	Stoermer et al. 1999
Encyonema muelleri (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Encyonema muelleri f. ventricosa (Tempère & M. Peragallo) Czarnecki	Stoermer et al. 1999
Encyonema neomesianum Krammer	Johansen et al. 2004
Encyonema norvegicum (Grunow) Mills	Krammer 1997b
Encyonema parallelum M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1909
Encyonema perpusillum (A. Cleve) Mann in Round et al.	Hamilton et al. 1992
Encyonema prostratum Ralfs	Stoermer & Kreis 1978
Encyonema rugosum (Hustedt) D.G. Mann	Krammer 1997a
Encyonema silesiacum (Bleisch ex Rabenhorst) D.G. Mann in Round et al.	Stoermer et al. 1999
Encyonema silesiacum var. elegans Krammer	Krammer 1997a
Encyonema temperei Krammer	Krammer 1997b
Encyonema thermale Krammer	Krammer 1997b
Encyonema triangulatum Kützing	Stoermer et al. 1999
Encyonema trianguliforme Krammer	Krammer 1997a
Encyonema triangulum Kützing	Stoermer & Kreis 1978
Encyonema turgidum (Gregory) Grunow	Stoermer & Kreis 1978
Encyonema turgidum var. hebridicum	Cleve & Möller 1879
Enyconema turgidum var. ventricosa Tempère & Peragallo	Tempère & Peragallo 1889–1895
Encyonema ventricosa Kützing	Stoermer & Kreis 1978
Encyonema ventricosum var. angusta Krammer	Siver et al. 2005
Encyonema ventricosum var. stricta	Tempère & Peragallo 1909
Encyonema yellowstonianum Krammer	Krammer 1997a
Encyonopsis cesatii (Rabenhorst) Krammer	Krammer 1997b
Encyonposis floridana Krammer	Krammer 1997b
Encyonopsis kriegeri var. fossilis Krammer	Krammer 1997b
Encyonopsis microcephala (Grunow) Krammer	Krammer 1997b
Encyonopsis radialis Krammer	Krammer 1997b
Encyonopsis stodderi (Cleve) Krammer	Krammer 1997b
Encyonopsis subminuta Krammer in Reichardt & Krammer	Siver et al. 2005
Encyonopsis subspicula Krammer	Krammer 1997b
Encyonopsis substodderi Krammer	Krammer 1997b
Encyonopsis symmetrica Krammer	Krammer 1997b
Entomoneis alata (Ehrenberg) Ehrenberg	Stoermer et al. 1999
Entomoneis ornata (J.W. Bailey) Reimer	Stoermer & Kreis 1978
Entomoneis paludosa (W. Smith) Reimer	Camburn 1982
Entomoneis paludosa var. duplex (Donkin) Cleve	Kaczmarska & Rushforth 1983
Entomoneis pulchra (J.W. Bailey) Reimer	Patrick & Reimer 1975
Entomoneis robusta (McCall) Reimer	Patrick & Reimer 1975
Epithemia adnata (Kützing) Brébisson	Collins & Kalinsky 1977
Epithemia adnata var. minor (M. Peragallo & Héribaud) Patrick	Stoermer et al. 1999
Epithemia adnata var. porcellus (Kützing) Patrick	Collins & Kalinsky 1977
Epithemia adnata var. proboscidea (Kützing) Patrick	Stoermer et al. 1999
Epithemia adnata var. saxonica (Kützing) Patrick	Stoermer et al. 1999
Epithemia alpestris W. Smith	Stoermer & Kreis 1978
Epithemia amphicephala Grunow	Tempère & Peragallo 1909
Epithemia andrewsii Stoermer & Yang	Stoermer & Kreis 1978
Epithemia argus (Ehrenberg) Kützing	Stoermer & Kreis 1978
Epithemia argus var. alpestris Grunow	Stoermer & Kreis 1978

Name	Publication
Epithemia argus var. amphicephala Grunow	Stoermer & Kreis 1978
Epithemia argus var. longicornis (Ehrenberg) Grunow	Stoermer & Kreis 1978
Epithemia argus var. protracta A. Mayer	Patrick & Reimer 1975
Epithemia emarginata Andrews	Stoermer & Kreis 1978
Epithemia frickei Krammer	Stoermer et al. 1999
Epithemia gibba Kützing	Stoermer & Kreis 1978
Epithemia gibba var. parallela Grunow	Stoermer et al. 1999
Epithemia gibba var. ventricosa (Kützing) Grunow	Stoermer & Kreis 1978
Epithemia gibberula (Ehrenberg) Kützing	Stoermer & Kreis 1978
Epithemia gibberula var. producta Grunow	Boyer 1927b
Epithemia gibberula var. protracta	Tempère & Peragallo 1913
Epithemia hyndmanii W. Smith	Stoermer & Kreis 1978
Epithemia hyndmanii var. capitata M. Peragallo	Patrick & Reimer 1975
Epithemia hyndmanii var. perlonga Pantocsek	Tempère & Peragallo 1908
Epithemia intermedia Fricke	Stoermer & Kreis 1978
Epithemia muelleri Fricke	Stoermer & Kreis 1978
Epithemia ocellata (Ehrenberg) Kützing	Stoermer & Kreis 1978
Epithemia reicheltii Fricke	Stoermer & Kreis 1978
Epithemia rupestris W. Smith	H.L. Smith 1876–1888 (#152)
Epithemia smithii Carruthers	Stoermer & Kreis 1978
Epithemia sorex Kützing	Stoermer & Kreis 1978
Epithemia truncata M. Peragallo	Patrick & Reimer 1975
Epithemia truncata var. debilis M. Peragallo	Patrick & Reimer 1975
Epithemia turgida (Ehrenberg) Kützing	Stoermer & Kreis 1978
Epithemia turgida var. granulata (Ehrenberg) Brun	Stoermer & Kreis 1978
Epithemia turgida var. plicata Meister	
Epithemia turgida var. vertagus	Tempère & Peragallo 1909
Epithemia turgida var. westermannii (Ehrenberg) Grunow	Stoermer & Kreis 1978
Epithemia turgida var. zebrina (Ehrenberg) Rabenhorst	Stoermer et al. 1999
Epithemia ventricosa Ehrenberg	Stoermer & Kreis 1978
Epithemia westermannii var. stricta Tempère & Peragallo	Tempère & Peragallo 1909
Epithemia zebra (Ehrenberg) Kützing	Stoermer & Kreis 1978
Epithemia zebra f. minor	Tempère & Peragallo 1909
Epithemia zebra var. porcellus (Kützing) Grunow	Stoermer & Kreis 1978
Epithemia zebra var. proboscida Grunow	Tempère & Peragallo 1908
Epithemia zebra var. saxonica (Kützing) Grunow	Stoermer & Kreis 1978
Eucocconeis depressa (Cleve) Hustedt	Stoermer & Kreis 1978
Eucocconeis diluviana (Hustedt) Lange-Bertalot	Siver et al. 2005
Eucocconeis flexella (Kützing) Hustedt	Stoermer & Kreis 1978
Eucocconeis flexella var. alpestris (Brun) Hustedt	Stoermer & Kreis 1978
Eucocconeis lapponica Hustedt	Stoermer & Kreis 1978
Eucocconeis lapponica var. ninckei (Guermeur & Manguin) Edlund	Stoermer & Kreis 1978
Eucocconeis minuta (Cleve) Cleve	Stoermer & Kreis 1978
Eunotia aduncus Hohn & Hellerman	Hohn & Hellerman 1963
Eunotia amphioxys Ehrenberg	Patrick & Reimer 1966
Eunotia arcubus Norpel-Schempp & Lange-Bertalot	Stoermer et al. 1999
Eunotia arcus Ehrenberg	Stoermer & Kreis 1978
Eunotia arcus var. bidens Grunow	Stoermer & Kreis 1978
Eunotia arcus var. curta (Grunow) Schonfeldt	Patrick 1945
Eunotia arcus var. fallax Hustedt	Stoermer & Kreis 1978
Eunotia arcus var. plicata (Brun) Héribaud	Patrick & Reimer 1966
Eunotia arcus var. minor Grunow	Boyer 1927a
Eunotia arcus var. tenella Grunow	Tempère & Peragallo 1908
Eunotia arcus var. uncinata (Ehrenberg) Grunow	Patrick & Reimer 1966
Eunotia argus	Ehrenberg 1856

Name	Publication
Eunotia bactriana Ehrenberg	Boyer 1927a
Eunotia batavica f. gamma Berg	Patrick & Reimer 1966
Eunotia biceps Ehrenberg	Boyer 1927a
Eunotia bidens Ehrenberg	Stoermer et al. 1999
Eunotia bidentula W. Smith	Boyer 1927a
Eunotia bidentata W. Smith	Cleve & Möller 1879
Eunotia bigibba Kützing	Lawson & Rushforth 1975
Eunotia bigibba var. pumila Grunow	Camburn 1982
Eunotia bilii Lowe & Kociolek	Lowe & Kociolek 1984
Eunotia bilunaris var. mucophila Lange-Bertalot & Norpel	Dute et al. 2000
Eunotia camelus Ehrenberg	Boyer 1927a
Eunotia camelus f. dentata Berg	Patrick & Reimer 1966
Eunotia carolina Patrick	Patrick 1958
Eunotia catillifera Morrow in Morrow, Deason & Clayton	Morrow et al. 1981
Eunotia cistula	Ehrenberg 1856
Eunotia clavata Hustedt	Hustedt 1913
Eunotia clevei Grunow	Patrick & Reimer 1966
Eunotia collinsii Kalinsky	Kalinsky 1984
Eunotia compacta Hustedt	Hustedt 1913
Eunotia cordillera Hohn & Hellerman	Hohn & Hellerman 1963
Eunotia cristagalli Cleve	Camburn 1982
Eunotia curvata (Kützing) Lagerstedt	Stoermer & Kreis 1978
Eunotia curvata f. bergii Woodhead & Tweed	Camburn & Charles 2000
Eunotia curvata var. capitata Patrick	Whitford & Schumacher 1973
Eunotia curvata var. falcata (Brébisson) Berg	Clark & Rushforth 1977
Eunotia curvata var. subarcuata (Nageli) Woodhead & Tweed	Camburn 1982
Eunotia cygnus Ehrenberg	Patrick & Reimer 1966
Eunotia denticulata (Brébisson) Rabenhorst	Camburn & Charles 2000
Eunotia depressa Ehrenberg	Patrick & Reimer 1966
Eunotia didyma var. inflata Hustedt	Hustedt 1913
Eunotia dianae	Ehrenberg 1856
Eunotia diodon Ehrenberg	Stoermer & Kreis 1978
Eunotia diodon f. minor	Tempère & Peragallo 1908
Eunotia ehrenbergii Ralfs	Boyer 1927a
Eunotia edegans Østrup	Whitford & Schumacher 1973
Eunotia elegans Østrup	Camburn 1982
Eunotia elongata Rabenhorst	Patrick & Reimer 1966
Eunotia euryptera	Ehrenberg 1856
Eunotia exigua (Brébisson) Rabenhorst	Stoermer & Kreis 1978
Eunotia exigua var. bidens Hustedt	Hamilton et al. 1992
Eunotia exigua var. compacta Hustedt	Camburn & Charles 2000
Eunotia exigua var. tridentula Østrup	Camburn & Charles 2000
Eunotia exigua var. undulata Magdeburg	Hamilton et al. 1992
Eunotia faba Ehrenberg emend Van Heurck	Patrick 1945
Eunotia fallax A. Cleve	Camburn 1982
Eunotia fallax var. gracillima Krasske	Camburn 1982
Eunotia fallax var. groenlandica (Grunow) Lange-Bertalot & Norpel	Camburn & Charles 2000
Eunotia flectuosa (Brébisson) Grunow	Hohn & Hellerman 1963
Eunotia flexuosa Brébisson	Stoermer & Kreis 1978
Eunotia flexuosa var. eurycephala Grunow	Stoermer & Kreis 1978
Eunotia formica Ehrenberg	Stoermer & Kreis 1978
Eunotia formica f. alpha Berg	Patrick & Reimer 1966
Eunotia formica f. beta Berg	Patrick & Reimer 1966
Eunotia gibba Ehrenberg	Patrick & Reimer 1966
Eunotia gibberula	Ehrenberg 1856
Eunotia gibbosa Grunow	Boyer 1927a
Eunotia glacialis Meister	Hansmann 1973

Name	Publication
Eunotia gracilis (Ehrenberg) Rabenhorst	Stoermer & Kreis 1978
Eunotia gracilis f. major (M. Peragallo) Héribaud	Patrick & Reimer 1966
Eunotia granulata Ehrenberg	Stoermer & Kreis 1978
Eunotia gratella f. beta Berg	Patrick & Reimer 1966
Eunotia hemicyclus (Ehrenberg) Ralfs	Boyer 1927a
Eunotia hendecaodon	Ehrenberg 1856
Eunotia hexaglyphis Ehrenberg	Patrick 1958
Eunotia hinziae Simonsen 1987	Simonsen 1987
Eunotia hinziae var. diodon Simonsen 1987	Simonsen 1987
Eunotia iatriaensis Foged	Camburn & Charles 2000
Eunotia impressa Ehrenberg	Boyer 1927a
Eunotia incisa W. Smith	Stoermer & Kreis 1978
Eunotia incurvata Hustedt	Hustedt 1913
Eunotia indica Grunow	Patrick 1945
Eunotia inflata (Grunow) Norpel-Schempp & Lange-Bertalot	Stoermer et al. 1999
Eunotia intermedia (Krasske) Norpel-Schempp & Lange-Bertalot	Stoermer et al. 1999
Eunotia kentuccensis	Ehrenberg 1856
Eunotia kocheliensis O. Müller	Patrick & Reimer 1966
Eunotia lapponica Grunow ex A. Cleve	Patrick & Reimer 1966
Eunotia lata Hustedt	Hustedt 1933b
Eunotia librile Ehrenberg	Patrick & Reimer 1966
Eunotia longicornis	Ehrenberg 1856
Eunotia luna Ehrenberg	Boyer 1927a
Eunotia luna var. intermedia Hustedt ex Simonsen 1987	Hustedt 1913
Eunotia luna var. elongata Hustedt ex Simonsen 1987	Hustedt 1913
Eunotia luna var. aequalis Hustedt ex Simonsen 1987	Hustedt 1913
Eunotia luna var. globosa Hustedt ex Simonsen 1987	Hustedt 1913
Eunotia luna var. trapezica Hustedt	Hustedt 1913
Eunotia lunaris (Ehrenberg) Grunow	Stoermer & Kreis 1978
Eunotia lunaris var. attenuata A. Berg	Dixit & Smol 1995
Eunotia lunaris var. capitata Hustedt	Patrick 1945
Eunotia lunaris var. excisa Grunow	Stoermer & Kreis 1978
Eunotia lunaris var. subarcuata (Naegeli) Grunow	Hohn & Hellerman 1963
Eunotia lunula Ehrenberg	Patrick & Reimer 1966
Eunotia major Rabenhorst	Stoermer & Kreis 1978
Eunotia major f. compacta Berg	Patrick & Reimer 1966
Eunotia major f. excelsa Berg	Patrick & Reimer 1966
Eunotia major var. impressa (W. Smith) Rabenhorst	Stoermer & Kreis 1978
Eunotia major f. plectrum Berg	Patrick & Reimer 1966
Eunotia major var. ventricosa A. Cleve	Patrick & Reimer 1966
Eunotia meisteri Hustedt	Camburn 1982
Eunotia meisteri var. bidens Hustedt	Dixit & Smol 1995
Eunotia microcephala Krasske	Stoermer & Kreis 1978
Eunotia microcephala var. tridentata (Mayer) Hustedt	Camburn et al. 1978
Eunotia minor Rabenhorst	Tempère & Peragallo 1908
Eunotia mira var. ovata A. Berg	Bateman & Rushforth 1984
Eunotia monodon Ehrenberg	Stoermer & Kreis 1978
Eunotia monodon f. curta	Tempère & Peragallo 1909
Eunotia monodon var. bidens (Gregory) Hustedt	Scherer 1988
Eunotia monodon var. constricta Cleve-Euler	Whitford & Schumacher 1973
Eunotia monodon var. major (W. Smith) Hustedt	Stoermer & Kreis 1978
Eunotia monodon var. major f. bidens W. Smith	Hohn 1951
Eunotia monodontiforma Lange-Bertalot & Norpel	Stoermer et al. 1999
Eunotia mosis Ehrenberg	Rushforth & Merkley 1988
Eunotia naegelii Migula	Stoermer & Kreis 1978
Eunotia nivalis Hohn & Hellerman	Hohn & Hellerman 1963
Eunotia nodosa Ehrenberg	Patrick & Reimer 1966

Name	Publication
Eunotia nymanniana Grunow	Boyer 1927a
Eunotia obesa var. wardii Patrick	Patrick 1958
Eunotia paludosa Grunow	Potapova & Charles 2002
Eunotia paludosa var. trinacria (Krasske) Norpel	Camburn & Charles 2000
Eunotia papilio Ehrenberg	Hohn 1951
Eunotia paradoxa Ehrenberg	Patrick & Reimer 1966
Eunotia parallela Ehrenberg	Stoermer & Kreis 1978
Eunotia pectinalis (O. Müller) Rabenhorst	Stoermer & Kreis 1978
Eunotia pectinalis var. biarcuata Berg	Whitford & Schumacher 1973
Eunotia pectinalis f. curta	Tempère & Peragallo 1909
Eunotia pectinalis f. didymodon (Grunow) Berg	Patrick & Reimer 1966
Eunotia pectinalis var. elongatum	Aubert 1895
Eunotia pectinalis var. macilenta Grunow	Van Heurck & Grunow 1882–1885 (#138)
Eunotia pectinalis var. minor (Kützing) Rabenhorst	Stoermer & Kreis 1978
Eunotia pectinalis var. minor f. impressa (Ehrenberg) Hustedt	Patrick 1945
Eunotia pectinalis var. recta Mayer ex Patrick	Patrick 1945
Eunotia pectinalis var. stricta Rabenhorst	Boyer 1927a
Eunotia pectinalis var. soleirolii (Kützing) Boyer	Boyer 1927a
Eunotia pectinalis var. undulata (Ralfs) Rabenhorst	Stoermer & Kreis 1978
Eunotia pectinalis var. ventralis (Ehrenberg) Hustedt	Dodd 1987
Eunotia pectinalis var. ventricosa Grunow	Stoermer & Kreis 1978
Eunotia pectinalis f. minor (Dillwyn) Rabenhorst	Stoermer & Kreis 1978
Eunotia pentaglyphis Ehrenberg	Boyer 1927a
Eunotia perminuta (Grunow) Patrick	Patrick 1958
Eunotia perpusilla Grunow	Stoermer & Kreis 1978
Eunotia pirla Carter & Flower	Carter & Flower 1988
Eunotia pocosinensis Gaiser & Johansen	Gaiser & Johansen 2000
Eunotia polydentula var. perpusilla	Patrick 1968
Eunotia polyglyphis Ehrenberg	Tempère & Peragallo 1913
Eunotia praerupta Ehrenberg	Stoermer & Kreis 1978
Eunotia praerupta var. bidens (Ehrenberg) Grunow	Stoermer & Kreis 1978
Eunotia praerupta var. curta Grunow	Patrick 1945
Eunotia praerupta var. inflata Grunow	Stoermer & Kreis 1978
Eunotia praerupta var. laticeps f. curta Grunow	Stoermer & Kreis 1978
Eunotia praerupta var. monodon	Aubert 1895
Eunotia praerupta var. monodon f. polaris (A. Berg) Symoens	Camburn & Charles 2000
Eunotia praerupta-nana Berg	Patrick & Reimer 1966
Eunotia prionotus Ehrenberg	Patrick & Reimer 1966
Eunotia pseudolunaris Venkt.	Stoermer & Kreis 1978
Eunotia pseudo-parallela f. alpha Berg	Patrick & Reimer 1966
Eunotia punctastriatum Camburn & Charles	Camburn & Charles 2000
Eunotia quarternaria Ehrenberg	Patrick 1958
Eunotia rabenhorstii var. monodon Grunow	Patrick & Reimer 1966
Eunotia recta Hustedt 1913	Hustedt 1913
Eunotia reicheltii Hustedt 1913	Hustedt 1913
Eunotia reicheltii var. bidens Hustedt 1913	Hustedt 1913
Eunotia reicheltii var. triodon Hustedt 1913	Hustedt 1913
Eunotia rhomboidea Hustedt	Camburn 1982
Eunotia robusta Ralfs	Boyer 1927a
Eunotia robusta var. diadema	Patrick & Reimer 1966
Eunotia robusta var. heudecaodon Ralfs	Aubert 1895
Eunotia robusta var. tetraedron (Ehrenberg) Ralfs	Stoermer & Kreis 1978
Eunotia robusta var. triodon Ehrenberg	Aubert 1895
Eunotia rostellata Hustedt ex Patrick	Patrick 1945
Eunotia rostrata	Ehrenberg 1856
Eunotia sarekensis var. pumila (Grunow) S. Berg	Clark & Rushforth 1977
Eunotia schweikerdtii Cholnoky	Camburn et al. 1978

Name	Publication
Eunotia septena Ehrenberg	Patrick 1945
Eunotia septentrionalis Østrup	Stoermer & Kreis 1978
Eunotia serra Ehrenberg	Stoermer & Kreis 1978
Eunotia serra var. diadema (Ehrenberg) Patrick	Camburn 1982
Eunotia serraceniae Gaiser & Johansen	Gaiser & Johansen 2000
Eunotia sima Ehrenberg	Hustedt 1913
Eunotia soleirolii (Kützing) Rabenhorst	Patrick 1958
Eunotia sphaerula Ehrenberg	Patrick & Reimer 1966
Eunotia st.antonii	Ehrenberg 1856
Eunotia stevensonii Boyer	Boyer 1927a
Eunotia submonodon Hustedt 1913	Hustedt 1913
Eunotia sudetica O. Müller	Camburn 1982
Eunotia suecica A. Cleve	Patrick 1945
Eunotia tauntoniensis Hustedt	Boyer 1927a
Eunotia tenella (Grunow) Hustedt	Stoermer & Kreis 1978
Eunotia ternaria Ehrenberg	Patrick & Reimer 1966
Eunotia testudinata Berg	Kalinsky 1979
Eunotia tetraodon Ehrenberg	Boyer 1927a
Eunotia tetraodon f. minuta Berg	Patrick & Reimer 1966
Eunotia torula Hohn	Patrick & Reimer 1966
Eunotia tridentula Ehrenberg	Boyer 1927a
Eunotia tridentula var. perminuta Grunow	Hohn 1951
Eunotia triodon Ehrenberg	Boyer 1927a
Eunotia trinacria Krasske	Stoermer & Kreis 1978
Eunotia trinacria var. undulata Hustedt	Camburn 1982
Eunotia turgida	Ehrenberg 1856
Eunotia uncinata Ehrenberg	Cleve & Möller 1879
Eunotia undulata Ralfs	Tempère & Peragallo 1913
Eunotia valida Hustedt	Stoermer & Kreis 1978
Eunotia vanheurckii Patrick	Stoermer & Kreis 1978
Eunotia vanheurckii var. intermedia (Krasske) Patrick	Stoermer & Kreis 1978
Eunotia varioundulata Norpel & Lange-Bertalot in Lang-Bertalot et al.	Siver et al. 2005
Eunotia veneris (Kützing) De Toni	Boyer 1927a
Eunotia ventralis Ehrenberg	Hohn 1951
Eunotia westermanni	Ehrenberg 1856
Eunotia woleirotii (Kützing) Rabenhorst	Stoermer & Kreis 1978
Eunotia zasuminensis (Cabejszekowna) Korner	Kalinsky 1984
Eunotia zasuminensis var. minor Kalinsky	Kalinsky 1984
Eunotia zebra	Ehrenberg 1856
Eunotia zebrina Ehrenberg	Stoermer & Kreis 1978
Eunotia zygodon Ehrenberg	Boyer 1927a
Eunotia zygodon var. elongata Hustedt	Gaiser & Johansen 2000
Fallacia fracta (Hustedt ex Simonsen) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia helensis (Schulz) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia indifferens (Hustedt) D.G. Mann in Round et al.	Johansen et al. 2004
Fallacia insociabilis (Krasske) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia monoculata (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia omissa (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia pseudomuralis (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia pygmaea (Kützing) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia subhamulata (Grunow in Van Heurck) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia submitis (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Fallacia tenera (Hustedt) D.G. Mann	Potapova & Charles 2002
Fallacia vitrea (Østrup) D.G. Mann in Round et al.	Johansen et al. 2004
Fistulifera saprophila (Lange-Bertalot & Bonik) Lange-Bertalot	Johansen et al. 2004

Name	Publication
Fragilaria acidobionta Charles	Charles 1986
Fragilaria acuta Ehrenberg	Stoermer & Kreis 1978
Fragilaria aequalis Heiberg	Tempère & Peragallo 1909
Fragilaria aequalis var. major Tempère & Peragallo	Tempère & Peragallo 1909
Fragilaria aequalis var. producta Lagerstedt	Tempère & Peragallo 1908
Fragilaria arcus (Ehrenberg) Cleve	Stoermer & Kreis 1978
Fragilaria atomus Hustedt	Stoermer & Kreis 1978
Fragilaria bicapitata A. Mayer	Stoermer & Kreis 1978
Fragilaria biceps Ehrenberg	Patrick & Reimer 1966
Fragilaria bipunctata Ehrenberg	Stoermer & Kreis 1978
Fragilaria bidens Heiberg	Boyer 1927a
Fragilaria bituminosa Pantocsek	Tempère & Peragallo 1913
Fragilaria brevistriata Grunow	Stoermer & Kreis 1978
Fragilaria brevistriata var. binodis (Pantocsek) A. Cleve	Stoermer et al. 1999
Fragilaria brevistriata var. capitata Héribaud	Stoermer & Kreis 1978
Fragilaria brevistriata var. inflata (Pantocsek) Hustedt	Stoermer & Kreis 1978
Fragilaria brevistriata var. inflata f. curta Skvortzow	Reimer 1961
Fragilaria capucina Desm.	Stoermer & Kreis 1978
Fragilaria capucina var. acuta Grunow	Boyer 1927a
Fragilaria capucina var. acuminata Grunow	Boyer 1927a
Fragilaria capucina var. familiaris (Kützing) Hamilton & Siver in Siver et al.	Siver et al. 2005
Fragilaria capucina var. gracilis	Morales 2001
Fragilaria capucina var. lanceolata Grunow	Stoermer & Kreis 1978
Fragilaria capucina var. mesolepta Rabenhorst	Stoermer & Kreis 1978
Fragilaria capucina var. vaucheriae (Kützing) Lange-Bertalot	Kalinsky 1982
Fragilaria constricta Ehrenberg	Hansmann 1973
Fragilaria constricta f. stricta (A. Cleve) Hustedt	Stoermer & Kreis 1978
Fragilaria constricta var. tetranodis (A. Cleve) Hustedt	Hamilton et al. 1992
Fragilaria constricta var. trinodis Hustedt	Hamilton et al. 1992
Fragilaria construens (Ehrenberg) Grunow	Stoermer & Kreis 1978
Fragilaria construens var. bigibba A. Cleve	Stoermer & Kreis 1978
Fragilaria construens var. binodis (Ehrenberg) Grunow	Stoermer & Kreis 1978
Fragilaria construens var. capitata Héribaud	Stoermer & Kreis 1978
Fragilaria construens var. genuina	Tempère & Peragallo 1895
Fragilaria construens var. exigua (W. Smith) Schulz	Patrick & Reimer 1966
Fragilaria construens var. javanica Hustedt	Camburn et al. 1978
Fragilaria construens var. minuta Tempère & Peragallo	Stoermer & Kreis 1978
Fragilaria construens var. pumila Grunow	Stoermer & Kreis 1978
Fragilaria construens var. subsalina Hustedt	Stoermer & Kreis 1978
Fragilaria construens var. venter (Ehrenberg) Grunow	Stoermer & Kreis 1978
Fragilaria construens var. venter f. pusilla Grunow	Clark & Rushforth 1977
Fragilaria crotonensis Kitton	Stoermer & Kreis 1978
Fragilaria crotonensis var. oregona Sovereign	Stoermer & Kreis 1978
Fragilaria crotonensis var. prolongata Grunow	Stoermer & Kreis 1978
Fragilaria cuneata Ehrenberg	Patrick & Reimer 1966
Fragilaria dibolos Hohn & Hellerman	Hohn & Hellerman 1963
Fragilaria diophthalama (Ehrenberg) Ehrenberg	Patrick & Reimer 1966
Fragilaria elliptica Schumann	Patrick 1945
Fragilaria elliptica f. minor	Patrick & Reimer 1966
Fragilaria entomon Ehrenberg	Stoermer & Kreis 1978
Fragilaria eugramma Ehrenberg	Patrick & Reimer 1966
Fragilaria exigua Grunow	Camburn & Charles 2000
Fragilaria exiguiformis Lange-Bertalot	Potapova & Charles 2003
Fragilaria floridana Hanna	Hein 1981
Fragilaria glebula Hohn & Hellerman	Hohn & Hellerman 1963
Fragilaria gnathostoma Hohn	Patrick & Reimer 1966
Fragilaria gracillima A. Mayer	Stoermer & Kreis 1978

Name	Publication
Fragilaria harrisonii Grunow	Stoermer & Kreis 1978
Fragilaria harrisonii var. dubia Grunow	Stoermer & Kreis 1978
Fragilaria harrisonii var. rhomboides Grunow	Stoermer & Kreis 1978
Fragilaria heideni Østrup	Stoermer & Kreis 1978
Fragilaria heideni var. istvanffyi (Pantocsek) Hustedt	Stoermer & Kreis 1978
Fragilaria hungarica Pantocsek	Hamilton et al. 1992
Fragilaria hungarica var. tumida Cleve-Euler	Hamilton et al. 1992
Fragilaria hyemalis	Ehrenberg 1856
Fragilaria incisa (Boyer) Lange-Bertalot	Siver et al. 2005
Fragilaria inflata (Heiden) Hustedt	Stoermer & Kreis 1978
Fragilaria intermedia Grunow	Stoermer & Kreis 1978
Fragilaria intermedia var. continua A. Cleve	Stoermer & Kreis 1978
Fragilaria intermedia var. fallax (Grunow) A. Cleve	Stoermer & Kreis 1978
Fragilaria intermedia var. lanceolata Fusey	Stoermer et al. 1999
Fragilaria interstincta Hohn & Hellerman	Hohn & Hellerman 1963
Fragilaria javanica Hustedt	Scherer 1988
Fragilaria kriegeriana Krasske	Stoermer & Kreis 1978
Fragilaria lanceolata	Patrick & Reimer 1966
Fragilaria lancettula Schumann	Tempère & Peragallo 1908
Fragilaria lapponica Grunow	Stoermer & Kreis 1978
Fragilaria lapponica var. minuta Cleve	Kaczmarska & Rushforth 1983
Fragilaria lata (Cleve-Euler) Renberg	Hamilton et al. 1992
Fragilaria leptostauron (Ehrenberg) Hustedt	Stoermer & Kreis 1978
Fragilaria leptostauron var. dubia (Grunow) Hustedt	Stoermer & Kreis 1978
Fragilaria leptostauron var. fossilis (Grunow) Rehakova	Stoermer & Kreis 1978
Fragilaria leptostauron var. rhomboides (Grunow) Hustedt	Stoermer & Kreis 1978
Fragilaria levis Ehrenberg	Patrick & Reimer 1966
Fragilaria linearis Castracane	Stoermer & Kreis 1978
Fragilaria marina var. parva Tempère & Peragallo	Tempère & Peragallo 1908
Fragilaria mazamaensis (Sovereign) Lange-Bertalot	Williams & Round 1987
Fragilaria minuscula Grunow	Stoermer & Kreis 1978
Fragilaria mormonorum (Grunow) Boyer (?)	Boyer 1927a
Fragilaria mutabilis Grunow	Stoermer & Kreis 1978
Fragilaria mutabilis var. intercedens W. Smith	Stoermer & Kreis 1978
Fragilaria neoproducta Lange-Bertalot	Siver et al. 2005
Fragilaria nitida M. Peragallo & Héribaud	Tempère & Peragallo 1913
Fragilaria nitzschioides Grunow	Stoermer & Kreis 1978
Fragilaria oxyptera Ehrenberg	Patrick & Reimer 1966
Fragilaria pantocsekii var. binodis (Pantocsek) A. Cleve	Stoermer & Kreis 1978
Fragilaria paradoxa Ehrenberg	Patrick & Reimer 1966
Fragilaria parasitica (W. Smith) Grunow	Stoermer & Kreis 1978
Fragilaria pectinalis	Ehrenberg 1856
Fragilaria pennsylvanica Morales	Morales 2003
Fragilaria pinnata Ehrenberg	Stoermer & Kreis 1978
Fragilaria pinnata var. acuminata A. Mayer	Camburn & Charles 2000
Fragilaria pinnata var. intercedens (Grunow) Hustedt	Stoermer & Kreis 1978
Fragilaria pinnata var. lancettula (Schumann) Hustedt	Stoermer & Kreis 1978
Fragilaria pinnata var. lancettula f. subcapitata Fusey	Camburn & Charles 2000
Fragilaria pinnata var. subcapitata Frenguelli	Reimer 1966
Fragilaria pinnata var. trigona (Brun & Héribaud) Hustedt	Patrick & Reimer 1966
Fragilaria radians (Kützing) Williams & Round	Stoermer et al. 1999
Fragilaria rhabdosoma Ehrenberg	Patrick & Reimer 1966
Fragilaria rhodana Hohn & Hellerman	Hohn & Hellerman 1963
Fragilaria robusta Hustedt	Patrick & Reimer 1966
Fragilaria rostrata Ehrenberg	Patrick & Reimer 1966
Fragilaria similis Krasske	Grimes & Rushforth 1982
Fragilaria sinuata M. Peragallo	Patrick & Reimer 1966

Name	Publication
Fragilaria smithiana Grunow in Van Heurck	Patrick & Reimer 1966
Fragilaria socia (Wallace) Lange-Bertalot	Kalinsky 1982
Fragilaria spinosa Skvortzow	Stoermer & Kreis 1978
Fragilaria strangulata	Patrick & Roberts 1979
Fragilaria striolata Ehrenberg	Rushforth & Merkley 1988
Fragilaria sublika Hohn & Hellerman	Patrick & Reimer 1966
Fragilaria suboldenburgiana Camburn & Charles	Camburn & Charles 2000
Fragilaria synegrotesca Lange-Bertalot	Lange-Bertalot 1993
Fragilaria tenera (W. Smith) Lange-Bertalot	Kalinsky 1982
Fragilaria turgens Ehrenberg	Patrick & Reimer 1966
Fragilaria ulna (Nitzsch) Lange-Bertalot	Kalinsky 1982
Fragilaria ulna var. amphirhynchus (Ehrenberg) Kalinsky	Kalinsky 1982
Fragilaria ulna var. danica (Kützing) Kalinsky	Kalinsky 1982
Fragilaria undata W. Smith	Boyer 1927a
Fragilaria undata var. lobata Patrick	Patrick 1945
Fragilaria undata var. quadrata Hustedt	Hohn 1951
Fragilaria vaucheriae (Kützing) Peterson	Stoermer & Kreis 1978
Fragilaria vaucheriae var. capitellata (Grunow) Patrick	Stoermer & Kreis 1978
Fragilaria vaucheriae var. continua A. Cleve	Collins & Kalinsky 1977
Fragilaria vaucheriae f. contorta Lowe	Dodd 1987
Fragilaria vaucheria var. distans (Grunow) Boye Petersen	Patrick & Reimer 1966
Fragilaria vaucheriae var. fallax Grunow	Stoermer & Kreis 1978
Fragilaria vaucheriae var. lanceolata A. Mayer	Stoermer & Kreis 1978
Fragilaria vaucheriae var. parvula (Kützing) A. Cleve	Stoermer et al. 1999
Fragilaria vaucheriae var. truncata (Greville) Grunow	Stoermer & Kreis 1978
Fragilaria venter	Ehrenberg 1856
Fragilaria virescens Ralfs	Stoermer & Kreis 1978
Fragilaria virescens var. capitata Østrup	Stoermer & Kreis 1978
Fragilaria virescens var. clavata	Patrick 1968
Fragilaria virescens var. exigua Grunow in Van Heurck	Hamilton et al. 1992
Fragilaria virescens var. mesolepta (Ralfs) Schonfeldt	Stoermer & Kreis 1978
Fragilaria virescens var. nipha Hohn & Hellerman	Hohn & Hellerman 1963
Fragilaria virescens var. oblongella Grunow	Stoermer & Kreis 1978
Fragilaria virescens var. producta Lagrstedt	Tilden 1894–1909 (#119)
Fragilaria virescens var. subsalina Grunow	Patrick & Reimer 1966
Fragilariforma acidobionta (Charles) Williams & Round	Williams & Round 1987
Fragilariforma bicapitata (Mayer) Williams & Round	Stoermer et al. 1999
Fragilariforma constricta (Ehrenberg) Williams & Round	Stoermer et al. 1999
Fragilariforma constricta f. stricta (A. Cleve) Poulin	Stoermer et al. 1999
Fragilariforma constricta f. tetranodis (A. Cleve) Poulin in Hamilton et al.	Hamilton et al. 1992
Fragilariforma constricta var. trinodis (Hustedt) Hamilton in Hamilton et al.	Hamilton et al. 1992
Fragilariforma hungarica (Pantocsek) Hamilton in Hamilton et al.	Hamilton et al. 1992
Fragilariforma hungarica var. tumida (Cleve-Euler) Hamilton in Hamilton et al.	Hamilton et al. 1992
Fragilariforma lata (Cleve-Euler) Williams & Round	Hamilton et al. 1992
Fragilariforma virescens (Ralfs) Williams & Round	Stoermer et al. 1999
Fragilariforma virescens var. capitata (Østrup) Czarnecki	Stoermer et al. 1999
Fragilariforma virescens var. exigua (Grunow) Poulin in Hamilton et al.	Hamilton et al. 1992
Fragilariforma virescens var. mesolepta (Rabenhorst) Andresen et al.	Andresen et al. 2000
Fragilariforma virescens var. oblongella (Grunow) Andresen et al..	Andresen et al. 2000
Fragilariopsis linearis (Castracane) Hustedt	Stoermer et al. 1999
Frustulia asymmetrica (Cleve) Hustedt	Patrick & Reimer 1966
Frustulia bahlsii Edlund & Brant	Edlund & Brant 1997
Frustulia crassinervia (Brébisson) Lange-Bertalot & Krammer	Potapova & Charles 2003
Frustulia disjuncta Lange-Bertalot	Lange-Bertalot 2001

Name	Publication
Frustulia erifuga Lange-Bertalot & Krammer	Stoermer et al. 1999
Frustulia interposita (Lewis) Cleve	Patrick & Reimer 1966
Frustulia krammeri Lange-Bertalot & Metzeltin in Metzeltin & Lange-Bertalot	Siver et al. 2005
Frustulia longinqua Lange-Bertalot	Lange-Bertalot 2001
Frustulia pelliculosa Brébisson	H.L. Smith 1876–1888 (#171)
Frustulia pseudomagaliesmontana Camburn & Charles	Camburn & Charles 2000
Frustulia rhomboides (Ehrenberg) De Toni	Stoermer & Kreis 1978
Frustulia rhomboides var. amphipleuroides (Grunow) Cleve	Stoermer & Kreis 1978
Frustulia rhomboides var. capitata (A, Mayer) Patrick	Camburn 1982
Frustulia rhomboides var. crassinervia (Brébisson) Ross	Stoermer & Kreis 1978
Frustulia rhomboides f. occidentalis Sovereign	Patrick & Reimer 1966
Frustulia rhomboides var. saxonica (Rabenhorst) De Toni	Stoermer & Kreis 1978
Frustulia rhomboides var. saxonica f. capitata A. Mayer	Dodd 1987
Frustulia rhomboides var. saxonica f. undulata Hustedt	Dodd 1987
Frustulia rhomboides f. undulata Hustedt	Bateman & Rushforth 1984
Frustulia rhomboides var. viridula (Brébisson) Cleve	Stoermer et al. 1999
Frustulia saxonica Ehrenberg	Stoermer et al. 1999
Frustulia viridula (Brébisson) De Toni	Stoermer & Kreis 1978
Frustulia vulgaris (Thwaites) De Toni	Stoermer & Kreis 1978
Frustulia vulgaris var. capitata Krasske	Stoermer & Kreis 1978
Frustulia weinholdii Hustedt	Stoermer & Kreis 1978
Gallionella aurichalcea	Ehrenberg 1856
Gallionella coarctata	Ehrenberg 1856
Gallionella crenata	Ehrenberg 1856
Gaillonella [sic] crotonensis	H.L. Smith 1876–1888 (#678)
Gallionella distans (Ehrenberg)	Stoermer & Kreis 1978
Gallionella granulata	Ehrenberg 1856
Gallionella laevis	Ehrenberg 1856
Gallionella marylandica	Ehrenberg 1856
Gallionella procera	Ehrenberg 1856
Gallionella varians	Ehrenberg 1856
Geissleria acceptata (Hustedt) Lange-Bertalot & Metzeltin	Stoermer et al. 1999
Geissleria aikenensis (Patrick) Torg. & Oliveira	Potapova & Charles 2003
Geissleria declivis (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Geissleria decussis (Østrup) Lange-Bertalot & Metzeltin	Stoermer et al. 1999
Geissleria kriegeri (Krasske) Lange-Bertalot	Stoermer et al. 1999
Geissleria paludosa (Hustedt) Lange-Bertalot & Metzeltin	Stoermer et al. 1999
Geissleria schoenfeldii (Hustedt) Lange-Bertalot & Metzeltin	Stoermer et al. 1999
Geissleria similis (Krasske) Lange-Bertalot & Metzeltin	Stoermer et al. 1999
Geissleria tectissima (Lange-Bertalot) Lange-Bertalot	Stoermer et al. 1999
Geissleria thingvallae (Østrup) Metzeltin & Lange-Bertalot	Stoermer et al. 1999
Gloeonema gracile	Ehrenberg 1856
Gloeonema paradoxum Ehrenberg	Stoermer & Kreis 1978
Gloeonema triangulatum	Stoermer & Kreis 1978
Gloeonema virginianum	Ehrenberg 1856
Gomphocymbella ancyli (Cleve) Hustedt	Andresen & Stoermer 1978
Gomphoneis elegans (Grunow) Cleve	Boyer 1927b
Gomphoneis eriense (Grunow) Skvortzow in Skvortzow & Meyer	Stoermer & Kreis 1978
Gomphoneis eriense var. angularis Kociolek & Stoermer	Kociolek & Stoermer 1988
Gomphoneis eriense var. apiculata Stoermer in Reimer	Kociolek & Stoermer 1988
Gomphoneis eriense var. rostrata (M. Schmidt) Skvortzow in Skvortzow & Meyer	Kociolek & Stoermer 1988
Gomphoneis eriense var. variabilis Kociolek & Stoermer	Kociolek & Kingston 1999

Name	Publication
Gomphoneis geitleri Kociolek & Stoermer	Stoermer et al. 1999
Gomphoneis herculeana (Ehrenberg) Cleve	Stoermer & Kreis 1978
Gomphoneis herculeana var. abundans Kociolek & Stoermer	Kociolek & Stoermer 1988
Gomphoneis herculeana var. clavata Cleve	Patrick & Reimer 1975
Gomphoneis herculeana var. loweii Kociolek & Stoermer	Kociolek & Stoermer 1988
Gomphoneis herculeana var. robusta (Grunow) Cleve	Stoermer et al. 1999
Gomphoneis herculeana var. rostrata Tempère & Peragallo	Patrick & Reimer 1975
Gomphoneis herculeana var. septiceps M. Schmidt	Patrick & Reimer 1975
Gomphoneis linearis Kociolek & Stoermer	Kociolek & Stoermer 1986
Gomphoneis mammilla (Ehrenberg) Cleve	Boyer 1927b
Gomphoneis minuta (Stone) Kociolek & Stoermer	Kociolek & Kingston 1999
Gomphoneis olivaceum (Hornemann) Dawson ex Ross & Sims	Camburn 1982
Gomphoneis olivacea var. calcarea (Cleve) Poulin in Poulin et al.	Stoermer et al. 1999
Gomphoneis quadripunctata (Østrup) Dawson ex Ross & Sims	Stoermer et al. 1999
Gomphoneis quadripunctata var. cochleariformis Kociolek & Stoermer	Stoermer et al. 1999
Gomphoneis rostrata (Tempère & Peragallo) Kociolek & Stoermer	Kociolek & Stoermer 1988
Gomphoneis rostrata var. valida Kociolek & Stoermer	Kociolek & Stoermer 1988
Gomphoneis scapha M. Schmidt	Tempère & Peragallo 1909
Gomphoneis septa (Moghadam) Kociolek, Stoermer & Bahls	Kociolek & Stoermer 1986
Gomphoneis subherculeana Kociolek & Stoermer	Kociolek & Stoermer 1988
Gomphoneis trullata Kociolek & Stoermer	Kociolek & Stoermer 1986
Gomphonema abbreviatum Agardh	Stoermer & Kreis 1978
Gomphonema abbreviatum var. inflata Hustedt	Stoermer & Kreis 1978
Gomphonema acuminatum Ehrenberg	Stoermer & Kreis 1978
Gomphonema acuminatum var. brebissonii (Kützing) Cleve	Stoermer & Kreis 1978
Gomphonema acuminatum var. capitatum Mayer	Collins & Kalinsky 1977
Gomphonema acuminatum var. clavus (Brébisson) Grunow	Camburn 1982
Gomphonema acuminatum var. coronatum (Ehrenberg) Rabenhorst	Stoermer & Kreis 1978
Gomphonema acuminatum var. elongatum (W. Smith) Carr	Camburn 1982
Gomphonema acuminatum var. intermedia Grunow	Stoermer & Kreis 1978
Gomphonema acuminatum var. laticeps Ehrenberg	Stoermer & Kreis 1978
Gomphonema acuminatum var. obtusatum (Kützing) Grunow	Johansen et al. 2004
Gomphonema acuminatum var. pusillum Grunow	Stoermer & Kreis 1978
Gomphonema acuminatum var. trigonocephala (Ehrenberg) Grunow	Stoermer & Kreis 1978
Gomphonema acuminatum var. turris Ehrenberg	Stoermer & Kreis 1978
Gomphonema aequale Gregory	Boyer 1927b
Gomphonema affine Kützing	Camburn 1982
Gomphonema affine var. elongatum (Mayer) Millie & Lowe	Stoermer et al. 1999
Gomphonema affine var. insigne (Gregory) Andrews	Stoermer & Kreis 1978
Gomphonema affine f. major Grunow	Hohn & Hellerman 1963
Gomphonema affine var. rhombicum Reichardt	Reichardt 1999
Gomphonema americanum Ehrenberg	Stoermer & Kreis 1978
Gomphonema americobtusatum Reichardt & Lange-Bertalot	Reichardt 1999
Gomphonema angustatum (Kützing) Rabenhorst	Stoermer & Kreis 1978
Gomphonema angustatum var. angustissima	Tempère & Peragallo 1909
Gomphonema angustatum var. citera (Hohn & Hellerman) Patrick	Stoermer et al. 1999
Gomphonema angustatum var. elongata M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Gomphonema angustatum var. intermedia Grunow	Camburn 1982
Gomphonema angustatum var. linearis Hustedt	Collins & Kalinsky 1977
Gomphonema angustatum var. obesa Lauby	Gaufin et al. 1976
Gomphonema angustatum f. major Van Heurck	Reimer 1970
Gomphonema angustatum var. naviculiformis Mayer	Collins & Kalinsky 1977
Gomphonema angustatum var. obesa Lauby	Patrick 1968
Gomphonema angustatum var. obtusatum (Kützing) Van Heurck	Stoermer & Kreis 1978
Gomphonema angustatum var. productum Grunow	Stoermer & Kreis 1978
Gomphonema angustatum var. sarcophagus (Gregory) Grunow	Stoermer & Kreis 1978

Name	Publication
Gomphonema angustatum var. undulata Grunow	Stoermer & Kreis 1978
Gomphonema angustatum f. undulata Grunow	Stoermer & Kreis 1978
Gomphonema apicatum Ehrenberg	Patrick & Reimer 1975
Gomphonema apiculatum Ehrenberg	Ehrenberg 1843
Gomphonema apuncto Wallace	Kociolek & Kingston 1999
Gomphonema argus Ehrenberg	Patrick & Reimer 1975
Gomphonema augur Ehrenberg	Stoermer & Kreis 1978
Gomphonema augur var. gautieri Van Heurck	Dodd 1987
Gomphonema auritum Braun	Boyer 1927b
Gomphonema bohemicum Reichelt & Fricke	Stoermer & Kreis 1978
Gomphonema brasiliense Grunow	Stoermer & Kreis 1978
Gomphonema brasiliense var. rhombiformis	Patrick & Roberts 1979
Gomphonema brebissonii Kützing	Patrick & Reimer 1975
Gomphonema camburnii Metzeltin & Lange-Bertalot	Camburn & Charles 2000
Gomphonema capitatum Ehrenberg	Stoermer & Kreis 1978
Gomphonema carolinense Hagelstein	Hohn & Hellerman 1963
Gomphonema christensenii Lowe & Kociolek	Lowe & Kociolek 1984
Gomphonema citera Hohn & Hellerman	Hohn & Hellerman 1963
Gomphonema clavatum Ehrenberg	Patrick & Reimer 1975
Gomphonema clavaherculis	Ehrenberg 1856
Gomphonema clevei Fricke	Stoermer & Kreis 1978
Gomphonema commutatum Grunow	Patrick 1968
Gomphonema commutatum var. subramosum	Patrick & Reimer 1975
Gomphonema consector Hohn & Hellerman	Stoermer & Kreis 1978
Gomphonema constrictum Ehrenberg	Stoermer & Kreis 1978
Gomphonema constrictum var. capitata (Ehrenberg) Van Heurck	Stoermer & Kreis 1978
Gomphonema constrictum f. clavata Cleve-Euler	Clark & Rushforth 1977
Gomphonema constrictum var. cuneata A. Schmidt	Whitford & Schumacher 1973
Gomphonema constrictum var. elongata Héribaud & Peragallo	Stoermer 1964
Gomphonema constrictum var. subcapitatum Van Heurck	Boyer 1927b
Gomphonema coronatum Ehrenberg	Stoermer & Kreis 1978
Gomphonema cristatum Ralfs	H.L. Smith 1876–1888 (#171)
Gomphonema cumrhis Hohn & Hellerman	Hohn & Hellerman 1963
Gomphonema curvatum Kützing	Stoermer & Kreis 1978
Gomphonema cymbelliclinum Reichardt & Lange-Bertalot	Reichardt 1999
Gomphonema cygnus Ehrenberg	Ehrenberg 1843
Gomphonema dichotomum Kützing	Stoermer & Kreis 1978
Gomphonema elegans Grunow	Rushforth & Merkley 1988
Gomphonema elongatum W. Smith	Tempère & Peragallo 1912
Gomphonema eriense Grunow	Stoermer & Kreis 1978
Gomphonema exiguum Kützing	Elmore 1922
Gomphonema exilissima (Grunow) Lange-Bertalot & Reichardt	Stoermer et al. 1999
Gomphonema freesei Lowe & Kociolek	Lowe & Kociolek 1984
Gomphonema geminata (Lyngbye) Agardh	Stoermer & Kreis 1978
Gomphonema germainii Kociolek & Stoermer	Stoermer et al. 1999
Gomphonema gibba Wallace	Camburn 1982
Gomphonema giganteum Ehrenberg	Ehrenberg 1852
Gomphonema glans Ehrenberg	Patrick & Reimer 1975
Gomphonema globiferum Meister	Patrick & Reimer 1975
Gomphonema gracile Ehrenberg	Stoermer & Kreis 1978
Gomphonema gracile var. auritum (A. Braun) Grunow	Patrick 1945
Gomphonema gracile var. cymbelloides Grunow	Stoermer & Kreis 1978
Gomphonema gracile var. insignis Gregory	Collins & Kalinsky 1977
Gomphonema gracile var. intricatiforme Mayer	Bateman & Rushforth 1984
Gomphonema gracile var. lanceolata (Kützing) Cleve	Collins & Kalinsky 1977
Gomphonema gracile var. dichotoma (Kützing) Grunow	Stoermer & Kreis 1978
Gomphonema gracile f. major (Grunow) O. Müller	Hohn 1961

Name	Publication
Gomphonema gracile var. naviculacea (W. Smith) Cleve	Stoermer & Kreis 1978
Gomphonema gracile var. naviculoides (W. Smith) Grunow	Patrick 1945
Gomphonema gracile f. parva Van Heurck	Reimer 1970
Gomphonema grovei M. Schmidt	Stoermer & Kreis 1978
Gomphonema grovei var. lingulatum (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Gomphonema grunowii Patrick	Camburn 1982
Gomphonema hedinii Hustedt	Patrick & Reimer 1975
Gomphonema helveticum Brun	Stoermer & Kreis 1978
Gomphonema helveticum var. tenuis Hustedt	Stoermer & Kreis 1978
Gomphonema herculeanum Ehrenberg	Stoermer & Kreis 1978
Gomphonema herculeanum var. robusta Grunow	Stoermer & Kreis 1978
Gomphonema himantaneum Ehrenberg	H.L. Smith 1876–1888 (#563)
Gomphonema hotchkissii Van Landingham	Camburn 1982
Gomphonema innocens Reichardt	Reichardt 1999
Gomphonema insigne Gregory	Collins & Kalinsky 1977
Gomphonema instabilis Hohn & Hellerman	Collins & Kalinsky 1977
Gomphonema intermedium Grunow	Tempère & Peragallo 1909
Gomphonema intricatum Kützing	Stoermer & Kreis 1978
Gomphonema intricatum var. bohemicum (R. & F.) Cleve-Euler	Patrick & Reimer 1975
Gomphonema intricatum f. pusilla Mayer	Collins & Kalinsky 1977
Gomphonema intricatum var. dichotomum (Kützing) Grunow	Stoermer & Kreis 1978
Gomphonema intricatum var. fossilis Pantocsek	Stoermer & Kreis 1978
Gomphonema intricatum var. pumila Grunow	Stoermer & Kreis 1978
Gomphonema intricatum var. pulvinatum (Braun) Grunow	Camburn 1982
Gomphonema intricatum var. vibrio (Ehrenberg) Cleve	Stoermer & Kreis 1978
Gomphonema intricatum var. vibrio f. subcapitata A. Mayer	Patrick & Reimer 1975
Gomphonema kobayasii Kociolek & Kingston	Kociolek & Kingston 1999
Gomphonema lanceolatum Agardh	Collins & Kalinsky 1977
Gomphonema lanceolatum var. insignis (Gregory) Cleve	Stoermer & Kreis 1978
Gomphonema laticeps Ehrenberg	Stoermer & Kreis 1978
Gomphonema leptocampum Kociolek & Stoermer	Stoermer et al. 1999
Gomphonema linea	Ehrenberg 1856
Gomphonema lingulatiforme Lange-Bertalot & Reichardt	Potapova & Charles 2003
Gomphonema lingulatum Hustedt	Stoermer & Kreis 1978
Gomphonema lingulatum var. constricta Hustedt	Collins & Kalinsky 1977
Gomphonema longiceps Ehrenberg	Stoermer & Kreis 1978
Gomphonema longiceps var. montana (Schumann) Cleve	Stoermer & Kreis 1978
Gomphonema longiceps var. subclavata Grunow	Stoermer & Kreis 1978
Gomphonema longiceps var. subclavata f. gracilis Hustedt	Stoermer & Kreis 1978
Gomphonema longiceps f. gracilis Hustedt	Stoermer & Kreis 1978
Gomphonema longiceps f. suecica Grunow	Hansmann 1973
Gomphonema longicolle Ehrenberg	Patrick & Reimer 1975
Gomphonema louisiananum Kalinsky	Kalinsky 1984
Gomphonema maclaughlinii Reichardt	Reichardt 1999
Gomphonema mammilla Ehrenberg	Ehrenberg 1854
Gomphonema manubrium Fricke	Stoermer & Kreis 1978
Gomphonema mehleri Camburn	Camburn 1982
Gomphonema mexicanum Grunow	Reichardt 1999
Gomphonema micropus Kützing	Tempère & Peragallo 1908
Gomphonema minutissima Greville emend. Ehrenberg	Patrick & Reimer 1975
Gomphonema minutum Agardh	Kociolek & Kingston 1999
Gomphonema montanum Schumann	Stoermer & Kreis 1978
Gomphonema montanum var. acuminatum (Peragallo & Héribaud) A. Mayer	Patrick & Reimer 1975
Gomphonema montanum var. media Grunow	Collins & Kalinsky 1977
Gomphonema montanum var. subclavatum Grunow	Camburn 1982
Gomphonema montanum var. suecica Grunow	Patrick & Reimer 1975
Gomphonema mustela Ehrenberg	Andresen & Stoermer 1978

Name	Publication
Gomphonema mantezumense Czarnecki & Blinn	Czarnecki 1979
Gomphonema nasutum Ehrenberg	Patrick & Reimer 1975
Gomphonema novacula Hohn & Hellerman	Hohn & Hellerman 1963
Gomphonema obtusum	Ehrenberg 1856
Gomphonema olivaceoides Hustedt	Stoermer & Kreis 1978
Gomphonema olivaceoides var. cochleariformis Manguin	Stoermer & Kreis 1978
Gomphonema olivaceoides var. densestriata Foged	Stoermer & Kreis 1978
Gomphonema olivaceoides var. hutchinsoniana Patrick	Camburn 1982
Gomphonema olivaceum (Lyngbye) Kützing	Stoermer & Kreis 1978
Gomphonema olivaceum var. calcarea (Cleve) Cleve	Stoermer & Kreis 1978
Gomphonema olivaceum var. minutissima Hustedt	Stoermer & Kreis 1978
Gomphonema olivaceum var. olivaceoides (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Gomphonema olivaceum var. tenellum (Kützing) Cleve	Patrick & Reimer 1975
Gomphonema olivaceum var. vulgaris (Kützing) Grunow	Patrick & Reimer 1975
Gomphonema olor Ehrenberg	Ehrenberg 1849
Gomphonema oregonicum Ehrenberg	Tempère & Peragallo 1912
Gomphonema ovatum H.L. smith	Patrick & Reimer 1975
Gomphonema pachycladum Brebisson	Collins & Kalinsky 1977
Gomphonema pala Reichardt	Siver et al. 2005
Gomphonema parvulum (Kützing) Kützing	Stoermer & Kreis 1978
Gomphonema parvulum var. aequalis A. Mayer	Dodd 1987
Gomphonema parvulum var. subelliptica Cleve	Stoermer & Kreis 1978
Gomphonema parvulum var. exilissima Grunow	Stoermer & Kreis 1978
Gomphonema parvulum var. lagenula (Kützing) Frenguelli	Stoermer & Kreis 1978
Gomphonema parvulum var. micropus (Kützing) Cleve	Stoermer & Kreis 1978
Gomphonema parvulum var. parvulius Lange-Bertalot & Reichardt	Potapova & Charles 2003
Gomphonema parvulum var. subellipticum Cleve	Whitford & Schumacher 1973
Gomphonema patricki Kociolek & Stoermer	Kociolek et al. 1995
Gomphonema productum Lange-Bertalot & Reichardt	Stoermer et al. 1999
Gomphonema pseudoaugur Lange-Bertalot	Stoermer et al. 1999
Gomphonema pseudopusillum Reichardt	Reichardt 1999
Gomphonema pseudotenellum Lange-Bertalot	Stoermer et al. 1999
Gomphonema puiggarianum Grunow	Boyer 1927b
Gomphonema puiggarianum var. aequatorialis Cleve	Camburn 1982
Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot	Potapova & Charles 2002
Gomphonema pygmaeum Kociolek & Stoermer	Stoermer et al. 1999
Gomphonema quadripunctatum (Østrup) Wislough	Stoermer & Kreis 1978
Gomphonema reimeri (Camburn) Kociolek & Kingston	Kociolek & Kingston 1999
Gomphonema rhombicum Fricke	Camburn 1982
Gomphonema rhombicum f. minor Fricke	Sovereign 1958
Gomphonema robustum Grunow	Stoermer & Kreis 1978
Gomphonema rotundatum	Ehrenberg 1856
Gomphonema sagitta Schumann	Prescott & Dillard 1979
Gomphonema sarcophagus Gregory	Stoermer & Kreis 1978
Gomphonema semiapertum Grunow	Stoermer & Kreis 1978
Gomphonema septata Naegeli	Prescott & Dillard 1979
Gomphonema septum Moghadam	Patrick & Reimer 1975
Gomphonema simus Hohn & Hellerman	Hohn & Hellerman 1963
Gomphonema sparsistriatum (O. Müller) Engler	Patrick 1968
Gomphonema sparsistriatum f. maculatum Camburn	Camburn 1982
Gomphonema sphaerophorum Ehrenberg	Stoermer & Kreis 1978
Gomphonema sphaerophorum var. turgidum Ehrenberg	Patrick & Reimer 1975
Gomphonema stoermeri (M. Schmidt) Kociolek & Kingston	Kociolek & Kingston 1999
Gomphonema stonei Reichardt	Hohn & Hellerman 1963
Gomphonema subclavata var. mustela (Ehrenberg) Cleve	Stoermer & Kreis 1978
Gomphonema subclavata f. gracilis (Hustedt) Woodhead & Tweed	Stoermer & Kreis 1978
Gomphonema subclavatum (Grunow) Grunow	Stoermer & Kreis 1978

Name	Publication
Gomphonema subclavatum var. commutatum (Grunow) A. Mayer	Patrick & Reimer 1975
Gomphonema subclavatum var. mexicanum (Grunow) Patrick	Camburn 1982
Gomphonema subclavatum var. mustela (Ehrenberg) Cleve	Stoermer et al. 1999
Gomphonema submehleri Kociolek & Stoermer	Stoermer et al. 1999
Gomphonema subtile Ehrenberg	Stoermer & Kreis 1978
Gomphonema subtilis f. angusta	Tempère & Peragallo 1913
Gomphonema subtile var. sagitta (Schumann) Cleve	Stoermer & Kreis 1978
Gomphonema subventricosum Hustedt	Camburn 1982
Gomphonema superiorensis Kociolek & Stoermer	Stoermer et al. 1999
Gomphonema tackei var. brevistriatum Camburn	Camburn et al. 1978
Gomphonema tenellum Kützing	Camburn 1982
Gomphonema tergestinum (Grunow) Fricke	Stoermer & Kreis 1978
Gomphonema trigonocephalum Ehrenberg	Stoermer & Kreis 1978
Gomphonema truncatum Ehrenberg	Stoermer & Kreis 1978
Gomphonema truncatum var. capitatum (Ehrenberg) Patrick	Camburn 1982
Gomphonema truncatum var. cuneatum (Fricke) Camburn	Camburn 1982
Gomphonema truncatum var. elongata (Peragallo & Héribaud) Patrick	Patrick & Reimer 1975
Gomphonema truncatum var. macilentum Kociolek & Stoermer	Stoermer et al. 1999
Gomphonema truncatum var. turgidum (Ehrenberg) Patrick	Stoermer et al. 1999
Gomphonema tumens Kociolek & Stoermer	Kociolek & Stoermer 1991
Gomphonema turgidum Grunow	Stoermer & Kreis 1978
Gomphonema turris Ehrenberg	Stoermer & Kreis 1978
Gomphonema turritum	Ehrenberg 1856
Gomphonema validum Cleve	Patrick & Reimer 1975
Gomphonema validum var. elongatum Cleve	Patrick & Reimer 1975
Gomphonema variabilis Jurilj	Patrick & Reimer 1975
Gomphonema variostriatum Camburn & Charles	Camburn & Charles 2000
Gomphonema ventricosum Gregory	Stoermer & Kreis 1978
Gomphonema ventricosum var. maxima Cleve	Patrick & Reimer 1975
Gomphonema vibrio Ehrenberg	Stoermer & Kreis 1978
Gomphonema vibrio var. fossile (Pantocsek) R. Ross	Stoermer et al. 1999
Gomphonema vibrio intricatum (Kützing) R. Ross	Stoermer et al. 1999
Gomphonema vibrio var. pumilum (Grunow in Van Heurck) R. Ross	Stoermer et al. 1999
Gomphonitzschia exigua Sovereign	Sovereign 1958
Gomphosphenia lingulatiformis (Lange-Bertalot & Reichardt) Lange-Bertalot	Kociolek & Kingston 1999
Grammatophora stricta Ehrenberg	Rushforth & Merkley 1988
Grunowia sinuata Rabenhorst	Aubert 1895
Gyrosigma acuminatum (Kützing) Rabenhorst	Stoermer & Kreis 1978
Gyrosigma attenuatum (Kützing) Rabenhorst	Stoermer & Kreis 1978
Gyrosigma attenuatum var. hippocampus (W. Smith) Brock	Gaufin et al. 1976
Gyrosigma balticum (Ehrenberg) Rabenhorst	Kalinsky 1983
Gyrosigma delicatulum (W. Smith) Elmore	Elmore 1922
Gyrosigma distortum (W. Smith) Cleve	Hohn 1951
Gyrosigma distortum var. stauroneioides (Grunow) Cleve	Patrick & Reimer 1966
Gyrosigma exilis (Grunow) Reimer	Stoermer & Kreis 1978
Gyrosigma eximium (Thwaites) Boyer	Collins & Kalinsky 1977
Gyrosigma fasciola (Ehrenberg) Griffen & Henfrey	Rushforth & Merkley 1988
Gyrosigma kuetzingii (Grunow) Cleve	Stoermer & Kreis 1978
Gyrosigma macrum (W. Smith) Griffen & Henfrey	Collins & Kalinsky 1977
Gyrosigma nodiferum (Grunow) Reimer	Stoermer & Kreis 1978
Gyrosigma obliquum (Grunow) Boyer	Kalinsky 1983
Gyrosigma obscurum (W. Smith) Griffen & Henfrey	Camburn 1982

Name	Publication
Gyrosigma obtusatum (Sullivan & Wormley) Boyer	Camburn 1982
Gyrosigma parkeri (Harrison) Boyer	Stoermer & Kreis 1978
Gyrosigma parvulum (Kützing) Rabenhorst	Collins & Kalinsky 1977
Gyrosigma peisonis (Grunow) Hustedt	Collins & Kalinsky 1977
Gyrosigma reimeri Sterrenburg	Stoermer et al. 1999
Gyrosigma scalproides (Rabenhorst) Cleve	Stoermer & Kreis 1978
Gyrosigma scalproides var. obliqua (Grunow) Cleve	Patrick & Reimer 1966
Gyrosigma sciotense (Sullivan & Wormley) Cleve	Stoermer & Kreis 1978
Gyrosigma spencerii (Quekett) Griffen & Henfrey	Stoermer & Kreis 1978
Gyrosigma spencerii var. curvula (Grunow) Reimer	Stoermer & Kreis 1978
Gyrosigma spencerii var. nodifera Grunow	Stoermer & Kreis 1978
Gyrosigma strigile (W. Smith) Cleve	Stoermer & Kreis 1978
Gyrosigma temperei Cleve	Stoermer & Kreis 1978
Gyrosigma terryanum f. fontanum Reimer	Patrick & Reimer 1966
Gyrosigma wormleyi (Sullivant) Boyer	Stoermer & Kreis 1978
Hannaea arcus (Ehrenberg) Patrick	Stoermer & Kreis 1978
Hannaea arcus var. amphioxys (Rabenhorst) Patrick	Stoermer & Kreis 1978
Hannaea arcus var. linearis Holmboe	Stoermer & Kreis 1978
Hantzschia amphioxys (Ehrenberg) Grunow	Stoermer & Kreis 1978
Hantzschia amphioxys f. capitata O. Müller	Camburn 1982
Hantzschia amphioxys var. capitata O. Müller	Stoermer & Kreis 1978
Hantzschia amphioxys var. elongata Grunow	Tempère & Peragallo 1908
Hantzschia amphioxys var. intermedia Grunow	Clark & Rushforth 1977
Hantzschia amphioxys var. leptocephala Østrup	Clark & Rushforth 1977
Hantzschia amphioxys var. linearis (O. Müller) Cleve-Euler	Rushforth & Merkley 1988
Hantzschia amphioxys var. major Grunow	Hohn 1951
Hantzschia amphioxys var. vivax (Hantzsch) Grunow	Stoermer & Kreis 1978
Hantzschia distincta-punctate Hustedt	Hohn 1961
Hantzschia elongata Grunow	Boyer 1927b
Hantzschia pseudomarina Hustedt	Hohn 1951
Hantzschia virgata (Roper) Grunow in Grunow & Cleve	Stoermer et al. 1999
Hantzschia virgata var. capitellata Hustedt	Stoermer et al. 1999
Hantzschia vivax var. granulata M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Himantidium arcus Ehrenberg	Kalinsky 1983
Himantidium bidens Ehrenberg	Kalinsky 1983
Himantidium carinatum	Ehrenberg 1856
Himantidium gracile	Ehrenberg 1856
Himantidium monodon	Ehrenberg 1856
Himantidium parallelum Ehrenberg	Kalinsky 1983
Himantidium pectinale Kützing	Kalinsky 1983
Himantidium pectinale var. major	H.L. Smith 1876–1888 (#193)
Himantidium ternarium	Ehrenberg 1856
Himantidium undulatum W.Smith	Kalinsky 1983
Hippodonta capitata (Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski	Stoermer et al. 1999
Hippodonta costulata (Grunow) Lange-Bertalot, Metzeltin & Witkowski	Stoermer et al. 1999
Hippodonta hungarica (Grunow) Lange-Bertalot, Metzeltin & Witkowski	Stoermer et al. 1999
Hippodonta kaiseri Lange-Bertalot, Metzeltin & Witkowski	Lange-Bertalot et al. 1996
Hippodonta linearis (Østrup) Lange-Bertalot, Metzeltin & Witkowski	Stoermer et al. 1999
Hippodonta lueneburgensis (Grunow) Lange-Bertalot, Metzeltin & Witkowski	Stoermer et al. 1999
Hippodonta subcostulata (Hustedt) Lange-Bertalot, Metzeltin & Witkowski	Stoermer et al. 1999
Homoeocladia acicularis (Kützing) Kuntze	Elmore 1922
Homoeocladia amphibia (Grunow) Kuntze	Elmore 1922

Name	Publication
Homoeocladia amphioxys (Ehrenberg) Kuntze	Collins & Kalinsky 1977
Homoeocladia angustata (W. Smith) Kuntze	Elmore 1922
Homoeocladia apiculata (Gregory) Kuntze	Elmore 1922
Homoeocladia arcus (Buhlhein) Kuntze	Elmore 1922
Homoeocladia brebissonii (W. Smith) Kuntze	Elmore 1922
Homoeocladia commutata (Grunow) Kuntze	Elmore 1922
Homoeocladia dissipata (Kützing) Kuntze	Elmore 1922
Homoeocladia dubia (W. Smith) Elmore	Elmore 1922
Homoeocladia fasciculata (Grunow) Kuntze	Elmore 1922
Homoeocladia filiformis W. Smith	Boyer 1927b
Homoeocladia frustulum (Kützing) Kuntze	Elmore 1922
Homoeocladia hungarica (Grunow) Kuntze	Elmore 1922
Homoeocladia intermedia (Hantzsch) Kuntze	Elmore 1922
Homoeocladia lanceolata (W. Smith) Kuntze	Elmore 1922
Homoeocladia linearis (Agardh) Kuntze	Elmore 1922
Homoeocladia obtusa (Lyngbye) Elmore	Elmore 1922
Homoeocladia palea (Kützing) Kuntze	Collins & Kalinsky 1977
Homoeocladia paxillifer (Müller) Elmore	Elmore 1922
Homoeocladia punctata (W. Smith) Kuntze	Elmore 1922
Homoeocladia sigma (Kützing) Kuntze	Elmore 1922
Homoeocladia sigmoidea (Nitzsch) Elmore	Stoermer & Kreis 1978
Homoeocladia spectabilis (Ehrenberg) Kuntze	Elmore 1922
Homoeocladia subtilis (Grunow) Kuntze	Elmore 1922
Homoeocladia tabellaria (Grunow) Kuntze	Elmore 1922
Homoeocladia tryblionella (Hantzsch) Kuntze	Elmore 1922
Homoeocladia umbonata (Ehrenberg) Kuntze	Elmore 1922
Homoeocladia vermicularis (Kützing) Kuntze	Collins & Kalinsky 1977
Homoeocladia virgata (Roper) Kuntze	Elmore 1922
Homoeocladia vitrea (Norman) Kuntze	Elmore 1922
Hyalodiscus californicus	Collins & Kalinsky 1977
Hyalodiscus whitneyi Ehrenberg	Kaczmarska & Rushforth 1983
Hyalosynedra laevigata (Grunow) Williams & Round	Stoermer et al. 1999
Hydrosera triquetra Wallich	Whitford & Schumacher 1973
Karayevia clevei (Grunow in Cleve & Grunow) Round & Bukhtiyarova	Stoermer et al. 1999
Karayevia laterostrata (Hustedt) Round & Bukhtiyarova	Stoermer et al. 1999
Kobayasia jaagii (Meister) Lange-Bertalot	Stoermer et al. 1999
Kobayasia subtilissima (Cleve) Lange-Bertalot	Stoermer et al. 1999
Kobayasiella madumensis (Jørgensen) Lange-Bertalot	Siver et al. 2005
Kobayasiella pseudosubtillissima (Manguin) Lange-Bertalot	Siver et al. 2005
Kolbesia kolbei (Hustedt) Round & Bukhtiyarova	Stoermer et al. 1999
Kolbesia ploeonensis (Hustedt) Round & Bukhtiyarova	Stoermer et al. 1999
Krasskella kriegerana (Krasske) Ross & Sims	Camburn 1982
Lemnicola hungarica (Grunow) Round & Basson	Johansen et al. 2004
Licmophora flabellata	Whitford 1956
Licmophora gracilis (Ehrenberg) Grunow	Rushforth & Merkley 1988
Licmophora tincta (Agardh) Grunow	Whitford & Schumacher 1973

Name	Publication
Luticola cohnii (Hilse) D.G. Mann in Round et al.	Stoermer et al. 1999
Luticola goeppertiana (Bleisch) D.G. Mann in Round et al.	Johansen et al. 2004
Luticola mutica (Kützing) D.G. Mann in Round et al.	Stoermer et al. 1999
Luticola muticoides (Hustedt) D.G. Mann in Round et al.	Stoermer et al. 1999
Luticola muticopsis (Van Heurck) D.G. Mann in Round et al.	Stoermer et al. 1999
Luticola naviculoides Johansen in Johansen et al.	Johansen et al. 2004
Luticola nivalis (Ehrenberg) Andresen et al.	Andresen et al. 2000
Luticola saxophila (Bock ex Hustedt) D.G. Mann	Gaiser & Johansen 2000
Luticola stigma (Patrick) Johansen in Johansen et al.	Johansen et al. 2004
Luticola terminata (Hustedt) Johansen in Johansen et al.	Johansen et al. 2004
Luticola terminata var. rostrata (Krasske) Johansen in Johansen et al.	Johansen et al. 2004
Luticola undulata (Hilse) Andresen et al.	Andresen et al. 2000
Lysigonium crenulatum (Kützing) Kuntze	Elmore 1922
Lysigonium distans (Kützing) Kuntze	Elmore 1922
Lysigonium granulata (Ehrenberg) Kuntze	Stoermer & Kreis 1978
Lysigonium varians (Agardh) De Toni	Stoermer & Kreis 1978
Martyana martyi (Héribaud) Round in Round et al.	Stoermer et al. 1999
Mastogloia angusta Hustedt	Hustedt 1933
Mastogloia aquilegiae Grunow	Kaczmarska & Rushforth 1983
Mastogloia braunii Grunow	Stoermer & Kreis 1978
Mastogloia crucicula (Grunow) Cleve	Kalinsky 1984
Mastogloia dansei Thwaites	Hohn 1951
Mastogloia doddii Stoermer ex Hungerford	Reimer 1990
Mastogloia dubia Kützing	Kalinsky 1983
Mastogloia elliptica (Agardh) Schonfeldt	Elmore 1922
Mastogloia elliptica var. danseii (Thwaites) Cleve	Patrick & Reimer 1966
Mastogloia exigua Kützing	Tempère & Peragallo 1912
Mastogloia grevillei W. Smith	Stoermer & Kreis 1978
Mastogloia jurgensii Ag.	Kalinsky 1983
Mastogloia lacustris (Grunow) Van Heurck	Stoermer & Kreis 1978
Mastogloia lanceolata Kützing	Tilden 1894–1909 (#248)
Mastogloia pumila (Grunow) Cleve	Kalinsky 1983
Mastogloia smithii Thwaites	Stoermer & Kreis 1978
Mastogloia smithii var. amphicephala Grunow	Stoermer & Kreis 1978
Mastogloia smithii var. lacustris Grunow	Stoermer & Kreis 1978
Melosira agassizzi Ostenfeld	Stoermer & Kreis 1978
Melosira agassizzi var. malayensis Hustedt	Stoermer & Kreis 1978
Melosira ambigua (Grunow) O. Müller	Stoermer & Kreis 1978
Melosira arenaria Moore	Stoermer & Kreis 1978
Melosira arenti (Kolbe) Nagumo & Kobayasi	Hamilton et al. 1992
Melosira binderana Kützing	Stoermer & Kreis 1978
Melosira borreri Greville	Whitford 1956
Melosira canadensis Hustedt	Stoermer & Kreis 1978
Melosira crenulata (Ehrenberg) Kützing	Stoermer & Kreis 1978
Melosira crenulata var. tenuis Kützing	Stoermer & Kreis 1978
Melosira crotonensis (J.W. Bailey) H.L. Smith	Stoermer & Kreis 1978
Melosira dendroteres (Rabenhorst) R. Ross	Stoermer et al. 1999
Melosira dickiei (Thwaites) Kützing	Stoermer et al. 1999
Melosira distans (Ehrenberg) Kützing	Stoermer & Kreis 1978
Melosira distans var. africana Müller	Hamilton et al. 1992
Melosira distans var. alpigena Grunow	Stoermer & Kreis 1978
Melosira distans var. humilis Cleve-Euler	Camburn & Kingston 1986
Melosira distans var. limnetica O. Müller	Stoermer et al. 1999

Name	Publication
Melosira distans var. nivalis (W. Smith) Kirchner	Camburn & Kingston 1986
Melosira distans var. nivaloides Camburn	Camburn & Kingston 1986
Melosira distans var. pfaffiana (Reinsch) Grunow	Rushforth & Merkley 1988
Melosira distans var. tenella (Nygaard) Florin	Camburn & Kingston 1986
Melosira dubia Kützing	Rushforth et al. 1986
Melosira epidendron (Ehrenberg) Boyer	Boyer 1927a
Melosira granulata (Ehrenberg) Ralfs	Stoermer & Kreis 1978
Melosira granulata var. angustissima O. Müller	Stoermer & Kreis 1978
Melosira granulata var. angustissima f. curvata Grunow	Stoermer & Kreis 1978
Melosira granulata var. angustissima f. spiralis Müller	Whitford & Schumacher 1973
Melosira granulata f. curvata Grunow	Stoermer et al. 1999
Melosira granulata var. muzzanensis (Meister) Bethge	Stoermer & Kreis 1978
Melosira granulata var. procera (Ehrenberg) Grunow	Camburn 1982
Melosira granulata f. spiralis Grunow	Stoermer & Kreis 1978
Melosira herzogii Lemmermann	Camburn & Kingston 1986
Melosira islandica O. Müller	Stoermer & Kreis 1978
Melosira islandica subsp. helvetica O. Müller	Stoermer & Kreis 1978
Melosira italica (Ehrenberg) Kützing	Stoermer & Kreis 1978
Melosira italica var. multistriata Patrick	Hohn 1961
Melosria italica var. granulata Grunow	Whitford & Schumacher 1973
Melosria italica var. subarctica O. Müller	Gaufin et al. 1976
Melosira italica var. tenuis (Grunow). O. Müller	Stoermer et al. 1999
Melosira italica var. tenuissima (Grunow) O. Müller	Stoermer & Kreis 1978
Melosira italica var. valida Grunow	Stoermer & Kreis 1978
Melosira italica subsp. subarctica O. Müller	Stoermer & Kreis 1978
Melosira italica subsp. subarctica f. tenuissima (Grunow) Camburn	Camburn & Kingston 1986
Melosira juergensii C.A. Agardh	Dodd 1987
Melosira lacustris H.H. Chase	Stoermer & Kreis 1978
Melosira laevis (Ehrenberg) Grunow	Hohn 1951
Melosira lirata (Ehrenberg) Kützing	Camburn & Kingston 1986
Melosira lirata f. biseriata (Grunow) Camburn	Camburn & Kingston 1986
Melosira lirata var. lacustris Grunow	Camburn & Kingston 1986
Melosira longispina Hustedt	Stoermer & Kreis 1978
Melosira moniliformis (O.F. Müller) Agardh	J.W. Bailey 1851
Melosira nummuloides (Dillwyn) Agardh	Kalinsky 1983
Melosira nygaardii Camburn	Camburn & Kingston 1986
Melosira pensacolae A. Schmidt	Sovereign 1958
Melosira perglabra Østrup	Camburn & Kingston 1986
Melosira perglabra var. floriniae Camburn	Camburn & Kingston 1986
Melosira pseudoamericana Camburn	Camburn & Kingston 1986
Melosira punctata W. Smith	Cleve & Möller 1879
Melosira roseana Rabenhorst	Stoermer & Kreis 1978
Melosira roeseana var. epidendron (Ehrenberg) Grunow	Patrick 1945
Melosira scalaris Grunow	Tempère & Peragallo 1912
Melosira semilaevis Grunow	Tempère & Peragallo 1913
Melosira solida Eulenstein	Tempère & Peragallo 1912
Melosira tenuis Kützing	Tempère & Peragallo 1911
Melosira tenuis var. ambigua Grunow	Cleve & Möller 1879
Melosira tenuissima Grunow	Tempère & Peragallo 1911
Melosira undulata (Ehrenberg) Kützing	Stoermer & Kreis 1978
Melosira undulata var. debilis	Tempère & Peragallo 1913
Melosira undulata var. normanii Arnott	Stoermer & Kreis 1978
Melosira varians Agardh	Stoermer & Kreis 1978
Melosira varennarum M. Peragallo	Tempère & Peragallo 1909
Meridion alansmithii Brant	Brant 2003
Meridion anceps (Ehrenberg) Williams	Stoermer et al. 1999

Name	Publication
Meridion circulare (Greville) Agardh	Stoermer & Kreis 1978
Meridion circulare var. constrictum (Ralfs) Van Heurck	Stoermer & Kreis 1978
Meridion constricutm Ralfs	Stoermer & Kreis 1978
Meridion constrictum var. elongata Tempère & Peragallo	Tempère & Peragallo 1908
Meridion constrictum var. zinkenii Grunow	Tempère & Peragallo 1908
Meridion hohii Rhode	Rhode et al. 2001
Meridion lineare (H.L. Smith) D.M. Williams	Williams 1985
Meridion intermedium H.L. Smith	Stoermer & Kreis 1978
Meridion intermedium var. constrictum H.L. Smith	Stoermer & Kreis 1978
Meridion vernale Agardh	Stoermer & Kreis 1978
Meridion zenkenii Kützing	Tempère & Peragallo 1912
Microcostatus krasskei (Hustedt) Johansen & Sray	Johansen & Sray 1997
Microsiphona potamos Weber	Stoermer & Kreis 1978
Muelleria gibbula (Cleve) Spaulding & Stoermer	Spaulding et al. 1999
Muelleria terrestris (Petersen) Spaulding & Stoermer	Spaulding et al. 1999
Navicula abaujensis (Paut.) Beitr.	Myers 1989b
Navicula abiskoensis Hustedt	Collins & Kalinsky 1977
Navicula aboensis (Cleve) Hustedt	Stoermer & Kreis 1978
Navicula absoluta Hustedt	Stoermer & Kreis 1978
Navicula abunda Hustedt	Kalinsky 1983
Navicula acceptata Hustedt	Stoermer & Kreis 1978
Navicula accomoda Hustedt	Stoermer & Kreis 1978
Navicula achthera Hohn & Hellerman	Hohn & Hellerman 1963
Navicula acrosphaeria (Brébisson) Kützing	Elmore 1922
Navicula acrosphaeria var. brevis	Tempère & Peragallo 1909
Navicula acrosphaeria var. dilata Tempère & Peragallo	Tempère & Peragallo 1908
Navicula acrosphaeria var. laevis A. Schmidt	Tempère & Peragallo 1908
Navicula acrosphaeria var. minor M. Peragallo & Héribaud	Tempère & Peragallo 1908
Navicula admenda Hohn & Helleerman	Patrick & Reimer 1966
Navicula adnata Hustedt	Patrick & Reimer 1966
Navicula adumbrata Hohn & Hellerman	Patrick & Reimer 1966
Navicula adversa Krasske	Hohn & Hellerman 1963
Navicula aequalis (Ehrenberg) Kützing	Patrick & Reimer 1966
Navicula aestuarii Cleve	Tempère & Peragallo 1911
Navicula affinis Ehrenberg	Stoermer & Kreis 1978
Navicula affine f. maxima Ehrenberg	Tempère & Peragallo 1908
Navicula agma Hohn & Hellerman	Hohn & Hellerman 1963
Navicula agnita Hustedt	Stoermer et al. 1999
Navicula agrestis Hustedt	Hohn & Hellerman 1963
Navicula aikenenses Patrick	Stoermer & Kreis 1978
Navicula alea Hohn & Hellerman	Hohn & Hellerman 1963
Navicula algor Hohn & Hellerman	Patrick & Reimer 1966
Navicula alpina W. Smith	Aubert 1895
Navicula alpina var. elongata M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula ambigua Ehrenberg	Stoermer & Kreis 1978
Navicula ambigua var. craticularis Ehrenberg	Stoermer & Kreis 1978
Navicula americana Ehrenberg	Stoermer & Kreis 1978
Navicula americana var. alastos Hohn & Hellerman	Stoermer et al. 1999
Navicula americana var. bacillaris Peragallo & Héribaud	Stoermer 1964
Navicula americana var. minor Peragallo & Héribaud	Boyer 1927b
Navicula americana var. moesta Tempère & Peragallo	Patrick & Reimer 1966
Navicula ammophila var. flanatica (Grunow) Cleve	Patrick & Reimer 1966
Navicula amnicola Hohn & Hellerman	Hohn & Hellerman 1963

Name	Publication
Navicula amphibola Cleve	Boyer 1927b
Navicula amphibola var. perrieri Peragallo & Héribaud	Stoermer & Kreis 1978
Navicula amphibola var. polymorpha Fusey	Stoermer & Kreis 1978
Navicula amphibola var. stauroneiformis	Tempère & Peragallo 1909
Navicula amphiceros Kützing	Stoermer & Kreis 1978
Navicula amphigomphus Ehrenberg	Stoermer & Kreis 1978
Navicula amphilepta	Ehrenberg 1856
Navicula amphioxys Ehrenberg	Patrick & Reimer 1966
Navicula amphirhynchus Ehrenberg	Kalinsky 1983
Navicula amphisbaena Bory	Elmore 1922
Navicula amphisphenia Ehrenberg	Kalinsky 1983
Navicula ampliata Ehrenberg	Tempère & Peragallo 1909
Navicula amydalina Hustedt	Stoermer et al. 1999
Navicula anatis Hohn & Hellerman	Hohn & Hellerman 1963
Navicula anglica Ralfs	Stoermer & Kreis 1978
Navicula anglica var. lapponica Cleve-Euler	Clark & Rushforth 1977
Navicula anglica var. signata Hustedt	Stoermer & Kreis 1978
Navicula anglica var. subsalsa (Grunow) Cleve	Stoermer & Kreis 1978
Navicula angusta Grunow	Camburn 1982
Navicula anglica var. subsalsa (Grunow) Cleve	Stoermer & Kreis 1978
Navicula angustata W. Smith	Stoermer & Kreis 1978
Navicula annexa Hustedt	Dodd 1987
Navicula antinitescens M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula apiculata Brébisson	Patrick & Reimer 1966
Navicula appendiculata Kützing	Stoermer & Kreis 1978
Navicula arata Grunow	Boyer 1927b
Navicula arctissima A. Schmidt	Tempère & Peragallo 1913
Navicula arenaria Donkin	Patrick & Reimer 1966
Navicula arenula Hohn & Hellerman	Patrick & Reimer 1966
Navicula argutiola Hohn & Hellerman	Hohn & Hellerman 1963
Navicula arvensis Hustedt	Stoermer & Kreis 1978
Navicula arverna M. Peragallo & Héribaud	Patrick & Reimer 1966
Navicula aspera Ehrenberg	Tilden 1894–1909 (#367)
Navicula asymbasia Hohn & Hellerman	Hohn & Hellerman 1963
Navicula aszellus Weinhold ex Hustedt	Reimer 1970
Navicual atomoides Grunow in V.H.	Elmore 1922
Navicula atomus (Kützing) Grunow	Stoermer & Kreis 1978
Navicula atomus var. permitis (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Navicula atomus var. recondita (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Navicula auriculata Hustedt	Camburn 1982
Navicula aurora Sovereign	Stoermer & Kreis 1978
Navicula avenacea Brébisson in Grunow	Hohn 1961
Navicula bacillaris Gregory	Stoermer & Kreis 1978
Navicula bacillariformis Grunow	Stoermer & Kreis 1978
Navicula bacilloides Hustedt	Fee 1967
Navicula bacillum Ehrenberg	Stoermer & Kreis 1978
Navicula bacillum var. lepida (Gregory) Cleve	Rushforth & Merkley 1988
Navicula bacula Hohn & Hellerman	Hohn & Hellerman 1963
Navicula balcanica Hustedt	Stoermer & Kreis 1978
Navicula bastianii M. Pergallo in Tempère & Peragallo	Boyer 1927b
Navicula bdesma Hohn	Patrick & Reimer 1966
Navicula begeri Krasske	Stoermer & Kreis 1978
Navicual belliatula Archibald	Dodd 1987
Navicula bergenensis Hohn	Patrick & Reimer 1966
Navicula bicapitata Lagerstedt	Stoermer & Kreis 1978
Navicula bicapitata var. hybrida Grunow	Tempère & Peragallo 1908
Navicula bicapitellata Hustedt	Stoermer & Kreis 1978

Name	Publication
Navicula bicephala Hustedt	Stoermer & Kreis 1978
Navicula biceps Ehrenberg	Collins & Kalinsky 1977
Navicula biconica Patrick	Patrick 1959
Navicula bicontracta Østrup	Stoermer & Kreis 1978
Navicula bievexa Hohn	Patrick & Reimer 1966
Navicula binodis Ehrenberg	Stoermer & Kreis 1978
Navicula birhis Hohn	Patrick & Reimer 1966
Navicula bisulcata Lagerstedt	Elmore 1922
Navicula bita Hohn	Patrick & Reimer 1966
Navicula bogotensis var. ininterrupta M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula bogotensis var. undulata M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula bohemica Ehrenberg	Rushforth & Merkley 1988
Navicula borealis (Ehrenberg) Kützing	Elmore 1922
Navicula bottnica Grunow	Bateman & Rushforth 1984
Navicula braunii Grunow	Elmore 1922
Navicula braunii var. interrupta	Tempère & Peragallo 1908
Navicula brebissonii Kützing	Stoermer & Kreis 1978
Navicula brebissonii var. curta	Tempère & Peragallo 1913
Navicula brekkaensis J.B. Petersen	Bateman & Rushforth 1984
Navicula bremensis Hustedt	Dixit & Smol 1995
Navicula brevis Gregory	Collins & Kalinsky 1977
Navicula brevissima Hustedt	Gaiser & Johansen 2000
Navicula brockmannii Hustedt	Dodd 1987
Navicula bryophila Østrup	Patrick & Reimer 1966
Navicula bryophila Peterson	Stoermer & Kreis 1978
Navicula buccella Hohn & Hellerman	Patrick & Reimer 1966
Navicula caduca Hustedt	Hohn & Hellerman 1963
Navicula campylogramma Ehrenberg	Stoermer & Kreis 1978
Navicula canalis Patrick	Stoermer & Kreis 1978
Navicula cancellata var. retusa (Brébisson) Cleve	Patrick & Reimer 1966
Navicula canoris Hohn & Hellerman	Hohn & Hellerman 1963
Navicula capitata Ehrenberg	Stoermer & Kreis 1978
Navicula capitata var. hungarica (Grunow) Ross	Stoermer & Kreis 1978
Navicula capitata var. linearis (Østrup) Stoermer & Kreis	Stoermer & Kreis 1978
Navicula capitata var. luneburgensis (Grunow) Patrick	Stoermer & Kreis 1978
Navicula capitata var. lueneburgensis f. elegans Østrup	Stoermer et al. 1999
Navicula capitatoradiata Germain	Yearsley et al. 1992
Navicula capsa Hohn	Stoermer & Kreis 1978
Navicula caractacus Hohn & Hellerman	Hohn & Hellerman 1963
Navicula cardinalis Ehrenberg	Stoermer & Kreis 1978
Navicula cari Ehrenberg	Stoermer & Kreis 1978
Navicula cari var. angusta Grunow	Stoermer & Kreis 1978
Navicula carminata	Patrick 1968
Navicula carniolensis Hustedt	Hohn & Hellerman 1963
Navicula caroliniana Patrick	Stoermer & Kreis 1978
Navicula carolinensis Ehrenberg	Patrick & Reimer 1966
Navicula cascadensis Sovereign	Stoermer & Kreis 1978
Navicula caterva Hohn & Hellerman	Hohn & Hellerman 1963
Navicula cerneutia Hohn	Patrick & Reimer 1966
Navicula certa Hustedt	Stoermer & Kreis 1978
Navicula charlatii M. Peragallo	Dodd 1987
Navicula charlatii f. simplex Hustedt	Loescher 1981
Navicula cincta (Ehrenberg) Ralfs	Stoermer & Kreis 1978
Navicula cincta var. angusta (Grunow) Cleve	Patrick 1945
Navicula cincta var. heufleri	Tempère & Peragallo 1909
Navicula cincta var. leptocephala Brébisson ex Van Heurck	Collins & Kalinsky 1977
Navicula cincta var. minuta Grunow	Patrick & Reimer 1966

Name	Publication
Navicula cincta var. rostrata Reimer	Collins & Kalinsky 1977
Navicula cinna Hohn & Hellerman	Hohn & Hellerman 1963
Navicula circumtexta Meister	Stoermer & Kreis 1978
Navicula citrus Krasske	Stoermer & Kreis 1978
Navicula clamans Hustedt	Stoermer & Kreis 1978
Navicula clementis Grunow	Stoermer & Kreis 1978
Navicula clementis var. linearis Brander	Stoermer & Kreis 1978
Navicula clementis var. quadristigmata Manguin	Stoermer & Kreis 1978
Navicula clementoides Hustedt	Stoermer et al. 1999
Navicula cocconeiformis Gregory	Stoermer & Kreis 1978
Navicula cocconeis (Ehrenberg) De Toni	Patrick & Reimer 1966
Navicula columbiana Hustedt	Hustedt 1966
Navicula columnaris Ehrenberg	Tempère & Peragallo 1908
Navicula commutata Grunow	Tempère & Peragallo 1909
Navicula complanatula Hustedt	Hustedt 1962
Navicula concava Patrick	Patrick 1945
Navicula confervacea (Kützing) Grunow	Stoermer & Kreis 1978
Navicula confervacea var. peregrina (W. Smith) Grunow	Stoermer & Kreis 1978
Navicula constans Hustedt	Clark & Rushforth 1977
Navicula constans var. symmetrica Hustedt	Stoermer & Kreis 1978
Navicula contempta Hustedt	Collins & Kalinsky 1977
Navicula contenta Grunow	Stoermer & Kreis 1978
Navicula contenta f. biceps	Patrick 1968
Navicula contenta f. parallela (Petersen) Hustedt	Rushforth & Merkley 1988
Navicula contenta var. biceps (Arnott) Grunow	Stoermer & Kreis 1978
Navicula contortula Sovereign	Patrick & Reimer 1966
Navicula contraria Patrick	Stoermer & Kreis 1978
Navicula convergens Patrick	Patrick 1959
Navicula costata Ehrenberg	Tempère & Peragallo 1909
Navicula costulata Cleve & Grunow	Stoermer & Kreis 1978
Navicula costuloides Skvortzow	Stoermer et al. 1999
Navicula cremorne Hohn & Hellerman	Hohn & Hellerman 1963
Navicula cristula Hohn	Patrick & Reimer 1966
Navicula crucialis (O. Müller) Frenguelli	Kociolek & Herbst 1992
Navicula crucicula (W. Smith) Donkin	Stoermer & Kreis 1978
Navicula creuzburgensis var. multistriata Patrick	Patrick 1959
Navicula cryptocefalsa Lange-Bertalot	Stoermer et al. 1999
Navicula cryptocephala Kützing	Stoermer & Kreis 1978
Navicula cryptocephala var. exilis (Kützing) Grunow	Camburn 1982
Navicula cryptocephala var. intermedia Van Heurck	Stoermer & Kreis 1978
Navicula cryptocephala var. lancettula (Schumann) Grunow	Stoermer & Kreis 1978
Navicula cryptocephala f. minuta Boye Peterson	Hohn & Hellerman 1963
Navicula cryptocephala var. pumila Grunow	Patrick 1945
Navicula cryptocephala f. terrestris Lund	Collins & Kalinsky 1977
Navicula cryptocephala var. veneta (Kützing) Rabenhorst	Stoermer & Kreis 1978
Navicula cryptocephaloides Hustedt	Stoermer & Kreis 1978
Navicula cryptogaster Lowe	Lowe 1972–1973
Navicula cryptonella Lange-Bertalot	Stoermer et al. 1999
Navicula cryptotonella Lange-Bertalot	Potapova & Charles 2002
Navicula cuspidata (Kützing) Kützing	Stoermer & Kreis 1978
Navicula cuspidata var. ambigua (Ehrenberg) Cleve	Boyer 1927b
Navicula cuspidata var. danaica Grunow in Cleve	Patrick & Reimer 1966
Navicula cuspidata var. héribaudi Peragallo	Patrick & Reimer 1966
Navicula cuspidata var. major Meister	Boyer 1927b
Navicula cuspidata var. obtusa Patrick	Patrick & Reimer 1966
Navicula cynthia A. Schmidt	Collins & Kalinsky 1977
Navicula cyrpinus W. Smith	Tempère & Peragallo 1909

Name	Publication
Navicula dactylus Ehrenberg	Aubert Le Diatomiste #20
Navicula dailyi Reimer	Patrick & Reimer 1966
Navicula dariana A. Schmidt	Tempère & Peragallo 1908
Navicula declivis Hustedt	Stoermer et al. 1999
Navicula decurrens (Ehrenberg) Kützing	Elmore 1922
Navicula decussis Østrup	Stoermer & Kreis 1978
Navicula demerara Grunow ex Cleve	Patrick & Reimer 1966
Navicula demissa Hustedt	Drum 1981
Navicula denestriata Hustedt	Stoermer & Kreis 1978
Navicula detenta Hustedt	Stoermer et al. 1999
Navicula diagonalis	Patrick & Reimer 1966
Navicula dicephala Ehrenberg	Stoermer & Kreis 1978
Navicula dicephala var. abiskonensis (Hustedt) A. Cleve	Stoermer & Kreis 1978
Navicula dicephala var. elginensis (Gregory) Cleve	Stoermer & Kreis 1978
Navicula dicephala var. lata M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula dicephala var. subcapitata Grunow	Patrick & Reimer 1966
Navicula dibola Hohn	Patrick & Reimer 1966
Navicula difficillima Hustedt	Camburn & Charles 2000
Navicula difficillimoides Hustedt	Grimes & Rushforth 1982
Navicula digito-radiata (Gregory) Ralfs	Collins & Kalinsky 1977
Navicula digitulus Hustedt	Bateman & Rushforth 1984
Navicula dilatata Ehrenberg	Ehrenberg 1856
Navicula diluviana Krasske	Stoermer & Kreis 1978
Navicula diserta Hustedt	Kalinsky 1983
Navicula disjuncta Hustedt	Hamilton et al. 1992
Navicula dismutica Hustedt	Loescher 1981
Navicula disputans Patrick	Stoermer & Kreis 1978
Navicula dissipata Hustedt	Stoermer & Kreis 1978
Navicula distinctastriata Hohn & Hellerman	Stoermer & Kreis 1978
Navicula divergens (W. Smith) Ralfs	Stoermer & Kreis 1978
Navicula divergens var. bacillaris M.Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula dubia W. Smith	Stoermer & Kreis 1978
Navicula dubia var. acuminata Tempère & Peragallo	Tempère & Peragallo 1911
Navicula dulcis Patrick	Stoermer & Kreis 1978
Navicula duomedia Patrick	Patrick 1959
Navicula dystrophica Patrick	Patrick 1959
Navicula ebor Hohn & Hellerman	Hohn & Hellerman 1963
Navicula eiowana Ehrenberg	Patrick & Reimer 1966
Navicula elaphros Hohn & Hellerman	Hohn & Hellerman 1963
Navicula elata Gandhi	Collins & Kalinsky 1977
Navicula elegans W. Smith	Stoermer & Kreis 1978
Navicula elegans var. cuspidata Cleve	Hohn 1951
Navicula elegantissima M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula elginensis (Gregory) Ralfs	Stoermer & Kreis 1978
Navicula elginensis f. abiskoensis Hustedt	Clark & Rushforth 1977
Navicula elginensis var. lata (M. Peragallo) Patrick	Stoermer & Kreis 1978
Navicula elginensis var. neglecta (Krasske) Patrick	Camburn 1982
Navicula elginensis var. rostrata (A. Mayer) Patrick	Stoermer & Kreis 1978
Navicula elginensis var. subcapitata Grunow	Clark & Rushforth 1977
Navicula elliptica Kützing	Stoermer & Kreis 1978
Navicula elliptica var. minutissima Grunow	Stoermer & Kreis 1978
Navicula elliptica var. ostracodarum	Tempère & Peragallo 1909
Navicula elmorei Patrick	Patrick & Reimer 1966
Navicula elongata	Ehrenberg 1856
Navicula entomon Ehrenberg	Collins & Kalinsky 1977
Navicula eponka Hohn	Patrick & Reimer 1966
Navicula erifuga Lange-Bertalot	Johansen et al. 2004

Name	Publication
Navicula esox Ehrenberg	Ehrenberg 1856
Navicula evexa Sovereign	Patrick & Reimer 1966
Navicula excelsa Krasske	Stoermer & Kreis 1978
Navicula exigua (Gregory) Grunow	Stoermer & Kreis 1978
Navicula exigua var. capitata Patrick	Stoermer & Kreis 1978
Navicula exiguaformis Hustedt	Stoermer & Kreis 1978
Navicula exibuoides Hustedt	Stoermer & Kreis 1978
Navicula exilis Kützing	Stoermer & Kreis 1978
Navicula exilissima Grunow	Collins & Kalinsky 1977
Navicula explanata Hustedt	Stoermer & Kreis 1978
Navicula exselsa Krasske	Rushforth & Merkley 1988
Navicula exsul A. Schmidt	Patrick & Reimer 1966
Navicula falaisensis Grunow	Boyer 1927b
Navicula farta Hustedt	Stoermer & Kreis 1978
Navicula fasciata Lagerstedt	Tempère & Peragallo 1908
Navicula festiva Krasske	Stoermer & Kreis 1978
Navicula feuerborni Hustedt	Kaczmarska & Rushforth 1983
Navicula finnica Cleve	Tempère & Peragallo 1909
Navicula firma Kützing & Grunow	Aubert 1895
Navicula firma var. amphigomphus Ehrenberg	Cleve & Möller 1879
Navicula firma var. dilatata	Cleve & Möller 1878
Navicula firma var. iridis	Cleve & Möller 1879
Navicula firma var. subampliata	Tempère & Peragallo 1912
Navicula firma var. tumescens Grunow	Cleve & Möller 1878
Navicula flanatica Grunow	Kalinsky 1983
Navicula flavasinus Moghadam	Prescott & Dillard 1979
Navicula flexuosa	Ehrenberg 1856
Navicula flexuosa var. cuneata Tempère & Peragallo	Tempère & Peragallo 1909
Navicula fluens Hustedt	Dodd 1987
Navicula fluminitica Camburn	Camburn 1982
Navicula forcipata Greville	Patrick & Reimer 1966
Navicula formica Ehrenberg	Cleve & Möller 1878
Navicula fossalis Krasske	Collins & Kalinsky 1977
Navicula fracta Hustedt	Stoermer & Kreis 1978
Navicula fragilarioides Krasske	Bateman & Rushforth
Navicula friesneri Reimer	Patrick & Reimer 1966
Navicula fritschii Lund	Patrick & Reimer 1966
Navicula frugalis Hustedt	Hohn & Hellerman 1963
Navicula fulva (Nitzsch) Ehrenberg	Elmore 1922
Navicula fusidium Ehrenberg	Kalinsky 1983
Navicula gallica (W. Smith) Van Heurck	Johansen et al 1983
Navicula gallica var. nitzschioides Grunow	Patrick & Reimer 1966
Navicula gallica var. perpusilla (Grunow) Lange-Bertalot	Camburn & Charles 2000
Navicula gastriformis Hustedt	Stoermer & Kreis 1978
Navicula gastrum (Ehrenberg) Kützing	Stoermer & Kreis 1978
Navicula gastrum f. maxima Tempère & Peragallo	Tempère & Peragallo 1909
Navicula gastrum var. exigua (Gregory) Grunow	Patrick & Reimer 1966
Navicula gastrum var. signata Hustedt	Stoermer & Kreis 1978
Navicula gaufinii Moghadam	Prescott & Dillard 1979
Navicula genovefea Fusey	Hohn & Hellerman 1963
Navicula gentilis Donkin	Tempère & Peragallo 1908
Navicula germanii Wallich	Hohn 1961
Navicula germainii Wallace	Patrick 1968
Navicula gibba (Ehrenberg) Kützing	Stoermer & Kreis 1978
Navicula gibba var. hyalina	Tempère & Peragallo 1909
Navicula gibbosa Hustedt	Stoermer & Kreis 1978
Navicula gibbula Cleve	Patrick & Reimer 1966

Name	Publication
Navicula gigas Ehrenberg	Tempère & Peragallo 1908
Navicula globiceps Gregory	Stoermer & Kreis 1978
Navicula globosa Meister	Stoermer & Kreis 1978
Navicula globulifera Hustedt	Patrick 1945
Navicula goeppertiana (Bleisch) H.L. Smith	Stoermer et al. 1999
Navicula goersii Bahls	Bahls 1983
Navicula gottlandica Grunow	Stoermer & Kreis 1978
Navicula gracilis Ehrenberg	Stoermer & Kreis 1978
Navicula gracilis f. minor	Patrick 1968
Navicula gracilis var. schizonemoides Van Heurck	Stoermer & Kreis 1978
Navicula gracillima Ralfs	Tempère & Peragallo 1911
Navicula graciloides A. Mayer	Stoermer & Kreis 1978
Navicula gravistriata Patrick	Patrick 1959
Navicula gregaria Donkin	Stoermer & Kreis 1978
Navicula grimmei Krasske	Stoermer & Kreis 1978
Navicula guatemalensis Cleve & Grove	Patrick & Reimer 1966
Navicula guttata Grunow	Patrick & Reimer 1966
Navicula gysingensis Foged	Stoermer & Kreis 1978
Navicula habena Hohn & Hellerman	Hohn & Hellerman 1963
Navicula halophila (Grunow) Cleve	Stoermer & Kreis 1978
Navicula halophila var. minor Kolbe	Patrick 1945
Navicula halophila var. subcapitata Østrup	Collins & Kalinsky 1977
Navicula halophila f. tenuirostris Hustedt	Camburn 1982
Navicula hambergii Hustedt	Stoermer & Kreis 1978
Navicula harderi Hustedt	Prescott & Dillard 1979
Navicula hasta var. punctata Boyer	Patrick & Reimer 1966
Navicula hassiaca Krasske	Stoermer & Kreis 1978
Navicula hasta Pantocsek	Stoermer & Kreis 1978
Navicula hyalosirella Hustedt	Hustedt 1962
Navicula hebes Ralfs	Cleve & Möller 1878
Navicula helensis Schulz	Stoermer & Kreis 1978
Navicula hemiptera Kützing	Stoermer & Kreis 1978
Navicula hemiptera var. troiana Grunow	Cleve & Möller 1879
Navicula heroina A. Schmidt	Patrick & Reimer 1966
Navicula heufleri Grunow	Stoermer & Kreis 1978
Navicula heufleri var. leptocephala (Brébisson) Patrick	Stoermer & Kreis 1978
Navicula hexapla A. Schmidt	Patrick & Reimer 1966
Navicula hilseana Janisch	Tempère & Peragallo 1912
Navicula hitchcockii Ehrenberg	Stoermer & Kreis 1978
Navicula hudsonis Grunow	Kalinsky 1983
Navicula humerosa Brébisson	Patrick & Reimer 1966
Navicula humilis Donkin	Boyer 1927b
Navicula hungarica Grunow	Stoermer & Kreis 1978
Navicula hungarica var. capitata (Ehrenberg) Cleve	Stoermer & Kreis 1978
Navicula hungarica var. linearis Østrup	Stoermer & Kreis 1978
Navicula hustedtii Krasske	Camburn 1982
Navicula hustedtii f. obtusa (Hustedt) Hustedt	Stoermer & Kreis 1978
Navicula hustedtii f. philippina Skvortzow	Hohn & Hellerman 1963
Navicula hyalinula De Toni	Kalinsky 1983
Navicula icostauron (Ehrenberg) O'Meara	Van Heurck & Grunow 1881–1885 (#138)
Navicula illinoensis	Ehrenberg 1856
Navicula imbellis Hohn & Hellerman	Hohn & Hellerman 1963
Navicula imbricata Bock	Stoermer & Kreis 1978
Navicula ingrata Krasske	Prescott & Dillard 1979
Navicula importuna Hustedt	Stoermer et al. 1999
Navicula incerta Grunow	Stoermer & Kreis 1978
Navicula incomitatus Hohn & Hellerman	Patrick & Reimer 1966

Name	Publication
Navicula incomposita Hagelstein	Kalinsky 1983
Navicula incompta var. incurva Reimer	Reimer 1990
Navicula indemnis Hohn & Hellerman	Patrick & Reimer 1966
Navicula indianensis Reimer	Patrick & Reimer 1966
Navicula indifferens Hustedt	Hohn & Hellerman 1963
Navicula inflata Donkin	Stoermer & Kreis 1978
Navicula inflexa (Gregory) Ralfs	Stoermer & Kreis 1978
Navicula infrenis Hohn & Hellerman	Hohn & Hellerman 1963
Navicula ingenua Hustedt	Stoermer & Kreis 1978
Navicula ingrata Krasske	Stoermer & Kreis 1978
Navicula insignita Hustedt	Stoermer & Kreis 1978
Navicula insociabilis Krasske	Stoermer & Kreis 1978
Navicula insociabilis var. dissipatoides Hustedt	Stoermer & Kreis 1978
Navicula instabilis A. Schmidt	Tempère & Peragallo 1909
Navicula integra (W. Smith) Ralfs	Stoermer & Kreis 1978
Navicula interglacialis Hustedt	Stoermer et al. 1999
Navicula intermedia Lagerstedt	Elmore 1922
Navicula interrupta W. Smith	Tempère & Peragallo 1909
Navicula interrupta var. stauroneiformis	Tempère & Peragallo 1909
Navicula intracata Hustedt	Stoermer & Kreis 1978
Navicula iridis Ehrenberg	Stoermer & Kreis 1978
Navicula iridis var. affinis Ehrenberg	Stoermer & Kreis 1978
Navicula iridis var. amphigomphus Ehrenberg	Stoermer & Kreis 1978
Navicula iridis var. amphirhynchus (Ehrenberg) Cleve	Stoermer & Kreis 1978
Navicula iridis var. ampliata Ehrenberg	Tempère & Peragallo 1908
Navicula iridis var. firma W. Smith	Stoermer & Kreis 1978
Navicula iridis var. maxima	Tempère & Peragallo 1909
Navicula iridis var. producta W. Smith	Stoermer & Kreis 1978
Navicula illinoensis	Ehrenberg 1856
Navicula isocephala Ehrenberg	Cleve & Möller 1878
Navicula jaagi Meister	Stoermer & Kreis 1978
Navicula jaerenfeltii Hustedt	Stoermer & Kreis 1978
Navicula jentzschii Grunow	Stoermer & Kreis 1978
Navicula johnsonii O'Meara	Aubert 1895
Navicula karsia Hohn	Patrick & Reimer 1966
Navicula keeleyi Patrick	Camburn 1982
Navicula kincaidii Sovereign	Patrick & Reimer 1966
Navicula kisber Hohn & Hellerman	Patrick & Reimer 1966
Navicula kotschyi Grunow	Stoermer & Kreis 1978
Navicula krasskei Hustedt	Stoermer & Kreis 1978
Navicula lacunarum Grunow	Stoermer & Kreis 1978
Navicula lacustris Gregory	Stoermer & Kreis 1978
Navicula laevissima Kützing	Stoermer & Kreis 1978
Navicula laevissima f. fusticulus (Østrup) Camburn	Camburn et al. 1978
Navicula ladogensis Cleve	Stoermer & Kreis 1978
Navicula lagerheimii Cleve	Stoermer 1962
Navicula lagerheimii var. intermedia Hustedt	Hohn & Hellerman 1963
Navicula lagerstedtii Cleve	Patrick & Reimer 1966
Navicula lalia Hohn & Hellerman	Hohn & Hellerman 1963
Navicula lanceolata (Agardh) Kützing	Stoermer & Kreis 1978
Navicula lanceolata var. cymbula (Donkin) Cleve	Stoermer & Kreis 1978
Navicula lanceolata f. minuta Rabenhorst	Patrick & Reimer 1966
Navicula lanceolata var. tenuirostris	Stoermer et al. 1999
Navicula lapidosa Krasske	Collins & Kalinsky 1977
Navicula lata (Brébisson) Kützing	Elmore 1922
Navicula latelongitudinalis Patrick	Patrick 1959
Navicula latens Krasske	Stoermer & Kreis 1978

Name	Publication
Navicula lateropunctata Wallace	Stoermer & Kreis 1978
Navicula laterostrata Hustedt	Stoermer & Kreis 1978
Navicula latevittata Cleve	Tempère & Peragallo 1908
Navicula latissima Gregory	Patrick & Reimer 1966
Navicula legumen Ehrenberg	Elmore 1922
Navicula lenzii Hustedt	Stoermer et al. 1999
Navicula leptoceros	Ehrenberg 1856
Navicula leptogongyla Ehrenberg	Kalinsky 1983
Navicula leptorhynchus Ehrenberg	Patrick & Reimer 1966
Navicula leptosigma Ehrenberg	Patrick & Reimer 1966
Navicula leptostriata Jorgensen	Dixit & Smol 1995
Navicula leptotermia	Ehrenberg 1856
Navicula levanderi Hustedt	Stoermer & Kreis 1978
Navicula liburnica Grunow	Elmore 1922
Navicula limosa Kützing	Stoermer & Kreis 1978
Navicula limosa var. gibberula (Kützing) Grunow	Stoermer & Kreis 1978
Navicula limosa var. subinflata Grunow	Stoermer & Kreis 1978
Navicula limosa var. undulata Grunow	Stoermer & Kreis 1978
Navicula lineolata	Ehrenberg 1856
Navicula lirata Ehrenberg	Patrick & Reimer 1966
Navicula litos Hohn & Hellerman	Camburn 1982
Navicula longa Ralfs	Stoermer & Kreis 1978
Navicula longicephala Hustedt	Johansen et al 1983
Navicula longirostris Hustedt	Stoermer & Kreis 1978
Navicula lucidula Grunow	Patrick & Reimer 1966
Navicula ludloviana A. Schmidt	Boyer 1927b
Navicula lundstroemii Cleve	Stoermer & Kreis 1978
Navicula luzonensis Hustedt	Stoermer & Kreis 1978
Navicula lyra Ehrenberg	Hohn 1951
Navicula lyra var. elliptica A. Schmidt	Patrick & Reimer 1966
Navicula macilenta Cleve	Tempère & Peragallo 1909
Navicula maculata var. lanceolata Heiden	Patrick & Reimer 1966
Navicula maculata var. orbiculata Patrick	Patrick & Reimer 1966
Navicula major Kützing	Stoermer & Kreis 1978
Navicula major var. asymetrica	Tempère & Peragallo 1909
Navicula major var. dilatata M. Peragallo	Patrick & Reimer 1966
Navicula major var. maxima	Patrick & Reimer 1966
Navicula mandumensis Jorgensen	Camburn & Charles 2000
Navicula margaritaceae Hustedt	Johansen et al. 1983
Navicula maxima Gregory	Stoermer & Kreis 1978
Navicula meandrinoides Hustedt	Hustedt 1930
Navicula mediocris Krasske	Stoermer & Kreis 1978
Navicula mediocris var. intermedia Reimer	Reimer 1966
Navicula mediacomplexa Hohn & Hellerman	Patrick & Reimer 1966
Navicula mediahelos Hohn & Hellerman	Hohn & Hellerman 1963
Navicula medioconvexa Hustedt	Potapova & Charles 2002
Navicula megaloptera Ehrenberg	Tempère & Peragallo 1908
Navicula menisculoides Hustedt	Stoermer et al. 1999
Navicula menisculus Schumann	Stoermer & Kreis 1978
Navicula menisculus var. krenneri A. Cleve	Stoermer et al. 1999
Navicula menisculus f. linearis Reimer	Reimer 1970
Navicula meniscula var. muralis (Grunow) Lange–Bertalot	Yearsley et al. 1992
Navicula menisculus var. obtusa Hustedt	Stoermer & Kreis 1978
Navicula menisculus var. upsaliensis (Grunow) Grunow	Camburn 1982
Navicula meniscus Schumann	Stoermer et al. 1999
Navicula mesogongyla Ehrenberg	Kalinsky 1983
Navicula mesogongyla var. interrupta Cleve	Tempère & Peragallo 1908

Name	Publication
Navicula mesolepta Ehrenberg	Stoermer & Kreis 1978
Navicula mesolepta var. stauroneiformis Grunow	Tempère & Peragallo 1908
Navicula mesostyla Ehrenberg	Tempère & Peragallo 1908
Navicula mica Hohn & Hellerman	Hohn & Hellerman 1963
Navicula micropupula Cholnoky	Stoermer & Kreis 1978
Navicula microstauron var. stauroneiformis	Tempère & Peragallo 1909
Navicula migma Hohn & Hellerman	Hohn & Hellerman 1963
Navicula minima Grunow	Stoermer & Kreis 1978
Navicula minima var. atomoides (Grunow) Cleve	Patrick 1945
Navicula minima var. okamurae Skvortzow	Stoermer & Kreis 1978
Navicula minima var. pseudofossilis (Krasske) Reimer	Reimer 1966
Navicula minnewaukonensis Elmore	Stoermer & Kreis 1978
Navicula minthe Hohn & Hellerman	Hohn & Hellerman 1963
Navicula minuscula Grunow	Stoermer & Kreis 1978
Navicula minuscula f. linearis Reimer	Reimer 1970
Navicula minuscula var. alpestris Hustedt	Stoermer & Kreis 1978
Navicula minusculoides Hustedt	Stoermer & Kreis 1978
Navicula minuta	Patrick & Reimer 1966
Navicula mobiliensis Boyer	Collins & Kalinsky 1977
Navicula mobiliensis var. minor Patrick	Patrick 1959
Navicula modica Hustedt	Camburn & Charles 2000
Navicula molestiformis Hustedt	Grimes & Rushforth 1982
Navicula monmouthiana-stodderi Yermeloff	Boyer 1927b
Navicula monoculata Hustedt	Stoermer & Kreis 1978
Navicula montana Moghadam	Prescott & Dillard 1979
Navicula mournei Patrick	Patrick 1959
Navicula mucronata Elmore	Elmore 1922
Navicula multigramme Hohn & Hellerman	Hohn & Hellerman 1963
Navicula muraliformis Hustedt	Stoermer & Kreis 1978
Navicula muralis Grunow	Patrick 1945
Navicula murrayi West & West	Rushforth & Merkley 1988
Navicula muscerda Hohn	Patrick & Reimer 1966
Navicula mutica Kützing	Stoermer & Kreis 1978
Navicula mutica var. binodis Hustedt	Camburn 1982
Navicula mutica var. cohnii (Hilse) Grunow	Stoermer & Kreis 1978
Navicula mutica var. gibbosa McCall	Collins & Kalinsky 1977
Navicula mutica var. goeppertiana (Bleisch) Grunow	Collins & Kalinsky 1977
Navicula mutica f. intermedia Hustedt	Reimer 1970
Navicula mutica var. nivalis (Ehrenberg) Hustedt	Stoermer & Kreis 1978
Navicula mutica var. stigma Patrick	Patrick 1959
Navicula mutica var. tropica Hustedt	Collins & Kalinsky 1977
Navicula mutica var. tropica f. rostrata Krasske	Lowe & Kociolek 1984
Navicula mutica var. undulata (Hilse) Grunow	Stoermer & Kreis 1978
Navicula mutica var. ventricosa Kützing	Hohn 1951
Navicula mutica f. lanceolata Frenguelli	Camburn 1982
Navicula muticoides Hustedt	Stoermer & Kreis 1978
Navicula muticopsis Van Heurck	Stoermer & Kreis 1978
Navicula narinosa Hohn	Patrick & Reimer 1966
Navicula naumannii Hustedt	Camburn & Charles 2000
Navicula nemoris Hohn & Hellerman	Hohn & Hellerman 1963
Navicula neoventricosa Hustedt	Stoermer & Kreis 1978
Navicula nigrii de Notaris	Collins & Kalinsky 1977
Navicula nimbus Hohn & Hellerman	Hohn & Hellerman 1963
Navicula nivalis Ehrenberg	Collins & Kalinsky 1977
Navicula nobilis (Ehrenberg) Kützing	Stoermer & Kreis 1978
Navicula nobilis var. dactylus (Ehrenberg) Van Heurck	Myers 1898b
Navicula nodosa Ehrenberg	Elmore 1922

Name	Publication
Navicula nodosa f. curta Rabenhorst	Tempère & Peragallo 1908
Navicula nodulosa Kützing	Cleve & Möller 1879
Navicula nolens Simonsen	Kalinsky 1983
Navicula notha Wallace	Stoermer & Kreis 1978
Navicula nugalis Hohn & Hellerman	Hohn & Hellerman 1963
Navicula nyassensis O. Müller	Stoermer & Kreis 1978
Navicula nyassensis var. capitata O. Müller	Hohn & Hellerman 1963
Navicula nyassensis f. minor O. Müller	Stoermer & Kreis 1978
Navicula obdurata Hohn & Hellerman	Stoermer & Kreis 1978
Navicula oblonga (Kützing) Kützing	Stoermer & Kreis 1978
Navicula oblongata Kützing	Patrick & Reimer 1966
Navicula oblongiformis Hustedt	Hustedt 1934
Navicula oblongum var. subcapitata Pantocsek	Stoermer & Kreis 1978
Navicula obsidialis Hustedt	Reimer 1970
Navicula obsoleta Hustedt	Reimer 1970
Navicula obtusa	Ehrenberg 1856
Navicula obtuseprotracta	Hustedt 1966
Navicula ocallii Hohn	Patrick & Reimer 1966
Navicula oculata Krasske	Patrick & Reimer 1966
Navicula odiosa Wallace	Stoermer & Kreis 1978
Navicula ohiensis Ehrenberg	Patrick & Reimer 1966
Navicula okadae (Skvortzow) Nagumo & Kobayasi	Camburn & Charles 2000
Navicula omissa Hustedt	Collins & Kalinsky 1977
Navicula opportuna Hustedt	Stoermer et al. 1999
Navicula oppugnata Hustedt	Stoermer & Kreis 1978
Navicula orangiana Patrick	Patrick 1959
Navicula orbiculata Patrick	Patrick 1959
Navicula ordinaria Hustedt	Stoermer & Kreis 1978
Navicula oregonica	Ehrenberg 1856
Navicula oxigua (Gregory) Müller	Patrick & Reimer 1966
Navicula paanaensis A. Cleve	Stoermer & Kreis 1978
Navicula paca Hohn & Hellerman	Stoermer & Kreis 1978
Navicula pachyptera Ehrenberg	Tempère & Peragallo 1908
Navicula palpebralis Brébisson	Elmore 1922
Navicula paludosa Hustedt	Stoermer & Kreis 1978
Navicula paludosa f. rhomboidea Reimer	Reimer 1970
Navicula paludosa var. rhomboidea Hustedt	Collins & Kalinsky 1977
Navicula pampeana Frenguelli	Stoermer 1964
Navicula parablis Hohn & Hellerman	Hohn & Hellerman 1963
Navicula paramutica Bock	Rushforth & Merkley 1988
Navicula paramutica var. binodis Bock	Lawson & Rushforth 1975
Navicula parasubtilissima Kobayasi & Nagumo	Camburn & Charles 2000
Navicula paratunkae Peterson	Camburn 1982
Navicula parodia Hohn	Patrick & Reimer 1966
Navicula parva Ralfs	Stoermer & Kreis 1978
Navicula parva (Ehrenberg) Elmore	Elmore 1922
Navicula parva (Meneghin) Cleve	Kaczmarska & Rushforth 1983
Navicula paucivisitata Patrick	Patrick 1959
Navicula paulensis Grunow	Tempère & Peragallo 1913
Navicula pavillardi Hustedt	Kalinsky 1983
Navicula pelliculosa Hilse	Stoermer & Kreis 1978
Navicula pennata A. Schmidt	Patrick & Reimer 1966
Navicula pennsylvanica Patrick	Patrick & Reimer 1966
Navicula peratomus Hustedt	Stoermer & Kreis 1978
Navicula peregrina (Ehrenberg) Kützing	Stoermer & Kreis 1978
Navicula peregrina var. truncata M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Navicula peripunctata J. Brun	Tempère & Peragallo 1908

Name	Publication
Navicula permitis Hustedt	Stoermer & Kreis 1978
Navicula perpusilla Grunow	Stoermer & Kreis 1978
Navicula perpusilla var. distans Cleve-Euler	Patrick & Reimer 1966
Navicula perrotettii (Grunow) Cleve	Stoermer & Kreis 1978
Navicula perrotettii var. enervis Hustedt	Stoermer et al. 1999
Navicula perventralis Hustedt	Patrick & Reimer 1966
Navicula peticolasii M. Peragallo	Patrick & Reimer 1966
Navicula phyllodes	Ehrenberg 1856
Navicula placenta Ehrenberg	Stoermer & Kreis 1978
Navicula placentula (Ehrenberg) Kützing	Stoermer & Kreis 1978
Navicula placentula var. jenisseyensis (Grunow) Meister	Hohn 1951
Navicula placentula var. latiuscula (Grunow) Meister	Drum 1981
Navicula placentula var. maculata Hustedt	Stoermer et al. 1999
Navicula placentula var. rostrata A. Mayer	Stoermer & Kreis 1978
Navicula placentula f. rostrata A. Mayer	Camburn 1982
Navicula platalea Ehrenberg	Patrick & Reimer 1966
Navicula platycephala O. Müller	Stoermer & Kreis 1978
Navicula platysoma Ehrenberg	Stoermer & Kreis 1978
Navicula platysoma var. pantocsekii Wislough & Kolbe	Stoermer & Kreis 1978
Navicula platyventris Meister	Kalinsky 1983
Navicula pletura Hohn	Patrick & Reimer 1966
Navicula poconoensis Patrick	Patrick 1945
Navicula pollis	Van Heurck & Grunow 1882–1885 (#544)
Navicula polyonca Brebissona	Aubert 1895
Navicula polystricta var. circumstricta Grunow	Collins & Kalinsky 1977
Navicula porifera var. oppotuna (Hustedt) Lange-Bertalot	Stoermer et al. 1999
Navicula portomonttana Cleve	Bateman & Rushforth 1984
Navicula potzgeri Reimer	Stoermer & Kreis 1978
Navicula potgeri var. quadripunctata Reimer	Patrick & Reimer 1966
Navicula praeterita Hustedt	Stoermer et al. 1999
Navicula pragma Hohn & Hellerman	Hohn & Hellerman 1963
Navicula producta W. Smith	Stoermer & Kreis 1978
Navicula protracta (Grunow) Cleve	Stoermer & Kreis 1978
Navicula protracta var. elliptica Gallik	Stoermer & Kreis 1978
Navicula protracta f. subcapitata (Wils. & Por.) Hustedt	Stoermer & Kreis 1978
Navicula pseuanglica Lange-Bertalot	Stoermer et al. 1999
Navicula pseudoarvensis Hustedt	Camburn et al. 1978
Navicula pseudoatomus Lund	Loescher 1981
Navicula pseudobacillum Grunow	Stoermer & Kreis 1978
Navicula pseudocanalis	Patrick & Roberts 1979
Navicula pseudoclementis Hustedt	Stoermer & Kreis 1978
Navicula pseudocrassirostris Hustedt	Kaczmarska & Rushforth 1983
Navicula pseudoexillissima Hustedt	Fee 1967
Navicula pseudofrickia Patrick	Patrick & Reimer 1966
Navicula pseudolanceolata Lange-Bertalot	Siver et al. 2005
Navicula pseudomuralis Hustedt	Stoermer et al. 1999
Navicula pseudopelliculosa Manguin	Hohn & Hellerman 1963
Navicula pseudoreinhardtii Patrick	Stoermer & Kreis 1978
Navicula pseudoscutiformis Hustedt	Stoermer & Kreis 1978
Navicula pseudosilicula Hustedt	Bateman & Rushforth 1984
Navicula pseudosilicula var. olympica Sovereign	Patrick & Reimer 1966
Navicula pseudosubtilissima Manguin	Camburn & Charles 2000
Navicula pseudotuscula Hustedt	Grimes & Rushforth 1982
Navicula pseudoventralis Hustedt	Stoermer & Kreis 1978
Navicula punctata Donkin	Stoermer & Kreis 1978
Navicula pupula Kützing	Stoermer & Kreis 1978
Navicula pupula var. aquaeductae (Krasske) Hustedt	Stoermer & Kreis 1978

Name	Publication
Navicula pupula var. bacillarioides Grunow	Stoermer & Kreis 1978
Navicula pupula var. capitata Hustedt	Stoermer & Kreis 1978
Navicula pupula var. elliptica Hustedt	Stoermer & Kreis 1978
Navicula pupula var. lineare Tempère & Peragallo	Tempère & Peragallo 1908
Navicula pupula var. major O. Müller	Patrick & Reimer 1966
Navicula pupula var. minor Kützing	Tempère & Peragallo 1908
Navicula pupula f. minor	Tempère & Peragallo 1909
Navicula pupula f. minuta	Tempère & Peragallo 1909
Navicula pupula var. minuta Van Heurck	Clark & Rushforth 1977
Navicula pupula f. minutula Cholnoky	Hohn & Hellerman 1963
Navicula pupula var. mutata (Krasske) Hustedt	Stoermer & Kreis 1978
Navicula pupula var. rectangularis (Gregory) Cleve	Stoermer & Kreis 1978
Navicula pupula var. rostrata Hustedt	Stoermer & Kreis 1978
Navicula pupula f. rostrata Hustedt	Camburn 1982
Navicula pusilla W. Smith	Stoermer & Kreis 1978
Navicula pusilla var. lanceolata (Grunow) Grunow	Patrick & Reimer 1966
Navicula pusio Cleve	Prescott & Dillard 1979
Navicula pygmaea Kützing	Stoermer & Kreis 1978
Navicula quadripartita Hustedt	Stoermer & Kreis 1978
Navicula rabenhorstii Ralfs	Aubert 1895
Navicula radians	Patrick & Reimer 1966
Navicula radiosa Kützing	Stoermer & Kreis 1978
Navicula radiosa var. acuta Grunow	Tempère & Peragallo 1908
Navicula radiosa var. parva Wallace	Stoermer & Kreis 1978
Navicula radiosa var. subrostrata Cleve	Patrick & Reimer 1966
Navicula radiosa var. tenella (Brébisson) Grunow	Stoermer & Kreis 1978
Navicula radiosafallax Lange-Bertalot	Stoermer et al. 1999
Navicula rainierensis Sovereign	Patrick & Reimer 1966
Navicula rangoonensis (Grunow) Elmore	Elmore 1922
Navicula recava Hohn & Hellerman	Hohn & Hellerman 1963
Navicula recens Lange-Bertalot	Potapova & Charles 2003
Navicula recondita Torka	Stoermer & Kreis 1978
Navicula reichardtiana Lange-Bertalot	Potapova & Charles 2003
Navicula reinhardtii Grunow	Stoermer & Kreis 1978
Navicula reinhardtii var. elliptica Héribaud	Stoermer & Kreis 1978
Navicula retusa var. elongata	Patrick & Reimer 1966
Navicula rhodana Hohn & Hellerman	Patrick & Reimer 1966
Navicula rhomboides Grunow	Stoermer & Kreis 1978
Navicula rhomboides var. major	Cleve & Möller 1879
Navicula rhynchocephala Kützing	Stoermer & Kreis 1978
Navicula rhynchocephala var. amphiceros (Kützing) Grunow	Stoermer & Kreis 1978
Navicula rhynchocephala var. germainii (Wallace) Patrick	Stoermer & Kreis 1978
Navicula rhynchotella Lange-Bertalot	Stoermer et al. 1999
Navicula rivalis Hohn & Hellerman	Hohn & Hellerman 1963
Navicula rostellata Kützing	Stoermer & Kreis 1978
Navicula rostrata Ehrenberg	Elmore 1922
Navicula rotaeana (Rabenhorst) Grunow	Stoermer & Kreis 1978
Navicula rotaeana var. excentrica Grunow	Stoermer & Kreis 1978
Navicula rotunda Hustedt	Stoermer & Kreis 1978
Navicula rugula Hohn & Hellerman	Hohn & Hellerman 1963
Navicula rupestris Hantzsch	Myers 1898b
Navicula ruttneri Hustedt	Sovereign 1958
Navicula sabiniana Patrick	Stoermer & Kreis 1978
Navicula sagitta Hohn & Hellerman	Hohn & Hellerman 1963
Navicula salinarum Grunow	Stoermer & Kreis 1978
Navicula salinarum var. capitata Schulz	Kaczmarska & Rushforth 1983
Navicula salinarum var. intermedia (Grunow) Cleve	Stoermer & Kreis 1978

Name	Publication
Navicula salinicola Hustedt	Potapova & Charles 2003
Navicula sanctaecrucis Østrup	Camburn 1982
Navicula saprophila Lange-Bertalot & Bonik	Johansen et al. 1983
Navicula saugerii Desm.	Stoermer & Kreis 1978
Navicula savannahiana Patrick	Camburn 1982
Navicula scalprum	Ehrenberg 1856
Navicula schadei Krasske	Camburn & Charles 2000
Navicula schmassmannii Hustedt	Stoermer & Kreis 1978
Navicula schoenfeldii Hustedt	Stoermer & Kreis 1978
Navicula schroteri Meister	Hohn & Hellerman 1963
Navicula schroeteri var. escambia Patrick	Stoermer & Kreis 1978
Navicula schumanniana Grunow	Stoermer & Kreis 1978
Navicula schweinfurthii A. Schmidt	Aubert 1895
Navicula sculpta Ehrenberg	Stoermer & Kreis 1978
Navicula scutelloides W. Smith	Stoermer & Kreis 1978
Navicula scutelloides var. minutissima	Tempère & Peragallo 1909
Navicula scutelloides var. mocarensis Grunow	Patrick & Reimer 1966
Navicula scutiformis Grunow	Stoermer & Kreis 1978
Navicula scutula Hohn	Patrick & Reimer 1966
Navicula scutum Schumann	Patrick & Reimer 1966
Navicula secreta Pantocsek	Stoermer & Kreis 1978
Navicula secura Patrick	Stoermer & Kreis 1978
Navicula secreta var. apiculata Patrick	Camburn 1982
Navicula semen (Ehrenberg) Donkin	Boyer 1927b
Navicula semenoides Hustedt	Stoermer & Kreis 1978
Navicula seminuloides Hustedt	Stoermer & Kreis 1978
Navicula seminuloides var. sumatrana Hustedt	Sovereign 1958
Navicula seminulum Grunow	Stoermer & Kreis 1978
Navicula seminulum var. hustedtii Patrick	Camburn 1982
Navicula seminulum var. intermedia Hustedt	Stoermer & Kreis 1978
Navicula septata Hustedt	Rushforth & Merkley 1988
Navicula septenaria L.W. Bailey	Patrick & Reimer 1966
Navicula serians Kützing	Stoermer & Kreis 1978
Navicula serians var. follis Ehrenberg	Cleve & Möller 1879
Navicula serians var. minor	Tempère & Peragallo 1911
Navicula sigma Ehrenberg	Stoermer & Kreis 1978
Navicula silicula Ehrenberg	Elmore 1922
Navicula similis Krasske	Stoermer & Kreis 1978
Navicula simplex Krasske	Camburn 1982
Navicula simula Patrick	Patrick 1959
Navicula singularis Schmidt	Cleve & Möller 1878
Navicula skabitschewskyi Sabelina	Stoermer & Kreis 1978
Navicula skalenastriata Hohn	Patrick & Reimer 1966
Navicula spirata Hustedt	Collins & Kalinsky 1977
Navicula splendicula Van Landingham	Camburn 1982
Navicula smithii Brébisson	Stoermer & Kreis 1978
Navicula smithii var. dilatata M. Peragallo in Tempère & Pergallo	Tempère & Peragallo 1908
Navicula sohrensis Krasske	Bateman & Rushforth 1984
Navicula sohrensis var. hassiaca (Krasske) Lange-Bertalot	Camburn & Charles 2000
Navicula sorella Hohn & Hellerman	Patrick & Reimer 1966
Navicula sovereignae Hustedt	Stoermer & Kreis 1978
Navicula speciosa Hustedt	Hustedt 1913
Navicula sphaerophora Kützing	Stoermer & Kreis 1978
Navicula spicula (Hickie) Cleve	Kalinsky 1983
Navicula splendicula Van Landingham	Stoermer et al. 1999
Navicula stankovici Hustedt	Patrick & Reimer 1966
Navicula staurifera Thomas	Stoermer & Kreis 1978

Name	Publication
Navicula stauroneiformis Elmore	Patrick & Reimer 1966
Navicula stauroptera Ralfs	Tempère & Peragallo 1912
Navicula stauroptera var. parva (Ehrenberg) Grunow	Stoermer & Kreis 1978
Navicula stauroptera var. troiana Grunow	Cleve & Möller 1879
Navicula stodderi Greenl.	Cleve 1894
Navicula stomatophora Grunow	Tempère & Peragallo 1908
Navicula strenzkei Hustedt	Grimes & Rushforth 1982
Navicula stroemii Hustedt	Stoermer & Kreis 1978
Navicula stroesei (Østrup) Cleve	Stoermer & Kreis 1978
Navicula subacuta Ehrenberg	Tempère & Peragallo 1909
Navicula subadnata Hustedt	Lawson & Rushforth 1975
Navicula subarvensis Hustedt	Dodd 1987
Navicula subatomoides Hustedt	Patrick 1945
Navicula subbacillum Hustedt	Collins & Kalinsky 1977
Navicula subcapitata (Gregory) Ralfs	Elmore 1922
Navicula subcapitata var. stauroneiformis	Tempère & Peragallo 1908
Navicula subclementis Hustedt	Stoermer & Kreis 1978
Navicula subcontenta Hustedt	Reimer 1990
Navicula subcostulata Hustedt	Stoermer & Kreis 1978
Navicula subfasciata Patrick	Patrick 1959
Navicula subgastriformis Hustedt	Stoermer et al. 1999
Navicula subhalophila Hustedt	Stoermer & Kreis 1978
Navicula subhamulata Grunow	Stoermer & Kreis 1978
Navicula subhamulata var. undulata Hustedt	Stoermer & Kreis 1978
Navicula subhexagona Hustedt	Hustedt 1934
Navicula subinflata Grunow	Patrick & Reimer 1966
Navicula subinflatoides Hustedt	Czarnecki et al. 1981
Navicula sunminuscula Manguin	Hohn & Hellerman 1963
Navicula submitis Hustedt	Stoermer et al. 1999
Navicula submolesta Hustedt	Patrick & Reimer 1966
Navicula submuralis Hustedt	Stoermer & Kreis 1978
Navicula subocculata Hustedt	Stoermer & Kreis 1978
Navicula subrhynchocephala Hustedt	Stoermer & Kreis 1978
Navicula subrotundata Hustedt	Stoermer & Kreis 1978
Navicula subrotundata f. lanceolata Hustedt	Stoermer et al. 1999
Navicula subseminulum Hustedt	Stoermer & Kreis 1978
Navicula subsulcata Hustedt	Stoermer & Kreis 1978
Navicula subsulcatoides Hustedt	Kaczmarska & Rushforth 1983
Navicula subtilissima Cleve	Stoermer & Kreis 1978
Navicula suchlandtii Hustedt	Lowe & Kociolek 1984
Navicula swaniana Moghadam	Prescott & Dillard 1979
Navicula symmetrica Patrick	Stoermer & Kreis 1978
Navicula tabellaria Ehrenberg	Stoermer & Kreis 1978
Navicula tabellaria var. stauroneiformis	Aubert 1895
Navicula taedia Wallich	Patrick & Reimer 1966
Navicula tantula Hustedt	Stoermer & Kreis 1978
Navicula tantula var. minima Grunow	Collins & Kalinsky 1977
Navicula taraxa Hohn & Hellerman	Kalinsky 1983
Navicula tecta Krasske	Stoermer & Kreis 1978
Navicula tenella (Brébisson) Van Heurck	Stoermer & Kreis 1978
Navicula tenelloides Hustedt	Collins & Kalinsky 1977
Navicula tenera Hustedt	Collins & Kalinsky 1977
Navicula tenuicephala Hustedt	Dixit & Smol 1995
Navicula termes Ehrenberg	Stoermer & Kreis 1978
Navicula terminata Hustedt	Stoermer & Kreis 1978
Navicula terrestris Petersen	Dodd 1987
Navicula terrestris var. relicta f. triundulata Lund	Dodd 1987

Name	Publication
Navicula texana Patrick	Stoermer & Kreis 1978
Navicula thermes (Ehrenberg) A. Schmidt	Elmore 1922
Navicula thienemannii Hustedt	Reimer 1966
Navicula tracery Hohn & Hellerman	Patrick & Reimer 1966
Navicula transversa A. Schmidt	Tempère & Peragallo 1908
Navicula tridentula Krasske	Stoermer & Kreis 1978
Navicula triduentula var. parallela Krasske	Stoermer & Kreis 1978
Navicula trinodis Lewis	Stoermer & Kreis 1978
Navicula tripunctata (O.F. Müller) Bory	Stoermer & Kreis 1978
Navicula tripunctata var. cuneata (Lauby) Stoermer & Yang	Stoermer & Kreis 1978
Navicula tripunctata var. schizonemoides (Van Heurck) Patrick	Stoermer & Kreis 1978
Navicula trivialis Lange-Bertalot	Yearsely et al. 1992
Navicula trochus Schumann	Stoermer & Kreis 1978
Navicula tulugakii Carter	Rushforth & Merkley 1988
Navicula tumida W. Smith	Stoermer & Kreis 1978
Navicula tuscula Ehrenberg	Stoermer & Kreis 1978
Navicula tuscula var. angulata Hustedt	Stoermer et al. 1999
Navicula tuscula var. rostrata (Hustedt) Hustedt	Stoermer et al. 1999
Navicula tuscula f. minor Hustedt	Stoermer & Kreis 1978
Navicula tuscula f. obtusa (Hustedt) Hustedt	Stoermer & Kreis 1978
Navicula tuscula f. rostrata Hustedt	Stoermer & Kreis 1978
Navicula typografica Hustedt	Hustedt 1930
Navicula umbra Hohn & Hellerman	Hohn & Hellerman 1963
Navicula utermohleii Hustedt	Prescott & Dillard 1979
Navicula vanheurckii Patrick	Stoermer & Kreis 1978
Navicula varians Gregory	Stoermer & Kreis 1978
Navicula variostriata Krasske	Stoermer & Kreis 1978
Navicula vaucheriae J.B. Petersen	Stoermer et al. 1999
Navicula venerablis Hohn & Hellerman	Hohn & Hellerman 1963
Navicula veneta Kützing	Johansen et al. 2004
Navicula ventosa Hustedt	Stoermer & Kreis 1978
Navicula ventralis Krasske	Stoermer & Kreis 1978
Navicula ventralis var. chilensis Krasske	Hohn & Hellerman 1963
Navicula ventralis f. simplex Hustedt	Stoermer & Kreis 1978
Navicula ventricosa Kützing	Tempère & Peragallo 1908
Navicula ventricosa var. undulata	Tempère & Peragallo 1909
Navicula verecunda Hustedt	Stoermer & Kreis 1978
Navicula vetita Krasske	Dodd 1971
Navicula viridis (Nitzsch) Ehrenberg	Stoermer & Kreis 1978
Navicula viridis var. fallax Cleve	Tempère & Peragallo 1908
Navicula viridis var. commutata Grunow	Tempère & Peragallo 1908
Navicula viridula (Kützing) Ehrenberg	Stoermer & Kreis 1978
Navicula viridula var. argunensis Skvortzow	Collins & Kalinsky 1977
Navicula viridula var. avenacea (Brébisson) Van Heurck	Stoermer & Kreis 1978
Navicula viridula var. germainii (J.H. Wallace) Lange-Bertalot	Lange-Bertalot 1993
Navicula viridula var. linearis Hustedt	Stoermer & Kreis 1978
Navicula viridula var. rostellata (Kützing) Cleve	Stoermer & Kreis 1978
Navicula vitabunda Hustedt	Stoermer & Kreis 1978
Navicula vitabunda var. montana Moghadam	Prescott & Dillard 1979
Navicula vitiosa Schimanski	Camburn & Charles 2000
Navicula vulpina Kützing	Stoermer & Kreis 1978
Navicula vulpina var. avenacea (Van Heurck) Patrick	Stoermer et al. 1999
Navicula walkeri Sovereign	Patrick & Reimer 1966
Navicula wallacei Reimer	Camburn 1982
Navicula wardii Patrick	Patrick 1959
Navicula wittrockii (Lagerstedt) Tempère & M. Peragallo	Stoermer & Kreis 1978
Navicula wulffi Boye Peterson	Hohn & Hellerman 1963

Name	Publication
Navicula yarrensis Grunow	Kalinsky 1983
Navicula yorkensis Camburn	Camburn 1982
Navicula zanoni Hustedt	Stoermer & Kreis 1978
Neidium affine (Ehrenberg) Pfitzer	Stoermer & Kreis 1978
Neidium affine var. amphirhynchus (Ehrenberg) Cleve	Stoermer & Kreis 1978
Neidium affine var. bonsaensis Foged	Lowe 1972–1973
Neidium affine var. capitata Molder	Stoermer et al. 1999
Neidium affine var. ceylonicum (Skvortzow) Reimer	Stoermer & Kreis 1978
Neidium affine var. genuinum f. maxima Cleve	Boyer 1927b
Neidium affine var. hankense (Skvortzow) Reimer	Stoermer & Kreis 1978
Neidium affine var. humerus Reimer	Stoermer & Kreis 1978
Neidium affine var. longiceps (Gregory) Cleve	Camburn 1982
Neidium affine var. quadripunctatum (Hustedt) Hamilton	Camburn & Charles 2000
Neidium affine var. tenuirostris A. Mayer	Stoermer 1963
Neidium affine var. undulatum (Grunow) Cleve	Stoermer & Kreis 1978
Neidium alpinum Hustedt	Patrick & Reimer 1966
Neidium alpinum var. quadripunctatum (Hustedt) Hamilton	Hamilton et al. 1990
Neidium amphigomphus (Ehrenberg) Pfitzer	Stoermer & Kreis 1978
Neidium amphirhynchus (Ehrenberg) Boyer	Boyer 1927b
Neidium ampliatum (Ehrenberg) Krammer	Stoermer et al. 1999
Neidium apiculatum Reimer	Stoermer & Kreis 1978
Neidium apiculatum var. constrictum Reimer	Patrick & Reimer 1966
Neidium binode (Ehrenberg) Hustedt	Stoermer & Kreis 1978
Neidium bisulcatum (Lagestedt) Cleve	Stoermer & Kreis 1978
Neidium bisulcatum var. baicalense (Skvortzow & Meyer) Reimer	Stoermer & Kreis 1978
Neidium bisulcatum f. lineare (Østrup) Cleve-Euler	Bateman & Rushforth 1984
Neidium bisulcatum var. nipponicum Skvortzow	Patrick & Reimer 1966
Neidium bisulcatum var. subundulatum (Grunow) Reimer	Camburn 1982
Neidium bisulcatum f. undulata (O. Müller) Hustedt	Bateman & Rushforth 1984
Neidium bisulcatum var. undulatum O. Müller	Patrick 1945
Neidium boyeri Reimer	Patrick & Reimer 1966
Neidium calvum Østrup	Stoermer & Kreis 1978
Neidium cape-codii Siver & Hamilton in Siver et al.	Siver et al. 2003
Neidium decens (Pantocsek) Stoermer	Stoermer 1963
Neidium densestriatum (Østrup) Krammer	Hamilton et al. 1992
Neidium dilatatum (Ehrenberg) Cleve	Boyer 1927b
Neidium distincte-punctatum Hustedt	Stoermer & Kreis 1978
Neidium dubium (Ehrenberg) Cleve	Stoermer & Kreis 1978
Neidium dubium f. constrictum Hustedt	Stoermer & Kreis 1978
Neidium floridanum Reimer	Patrick & Reimer 1966
Neidium gracile f. aequale Hustedt	Patrick & Reimer 1966
Neidium hankensis Skvortzow	Stoermer 1963
Neidium hankensis var. elongata Skvortzow	Stoermer 1963
Neidium hercynicum A. Mayer	Camburn 1982
Neidium hercynicum f. subrostratum Wallace	Camburn 1982
Neidium herrmannii Hustedt	Patrick & Reimer 1966
Neidium hitchcockii (Ehrenberg) Cleve	Stoermer & Kreis 1978
Neidium hitchcockii f. teres Sovereign	Patrick & Reimer 1966
Neidium holstii (Cleve) Krammer	Camburn & Charles 2000
Neidium inconstans Sovereign	Patrick & Reimer 1966
Neidium iridis (Ehrenberg) Cleve	Stoermer & Kreis 1978
Neidium iridis var. amphigomphus (Ehrenberg) A. Mayer	Stoermer & Kreis 1978
Neidium iridis var. ampliatum (Ehrenberg) Cleve	Stoermer & Kreis 1978
Neidium iridis var. conspicua A. Mayer	Patrick & Reimer 1966
Neidium iridis var. intercedens A. Mayer	Schmidt & Fee 1967
Neidium iridis var. subundulatum (Cleve-Euler) Reimer	Patrick & Reimer 1966
Neidium iridis var. vernalis Reichelt	Stoermer & Kreis 1978

Name	Publication
Neidium knuthii var. heilprinensis Foged	Patrick & Reimer 1966
Neidium kozolwi Mereschkowsky	Stoermer & Kreis 1978
Neidium kozolwi var. baicalensis f. robusta Stoermer	Stoermer & Kreis 1978
Neidium kozlowii var. parvum Mereschkowsky	Patrick & Reimer 1966
Neidium kozlowi var. undulata Stoermer	Stoermer 1963
Neidium ladogense (Cleve) Stoermer & Yang	Stoermer & Kreis 1978
Neidium ladogense var. densestriatum (Østrup) Foged	Camburn 1982
Neidium ladogense var. densestriatum f. peribryum Lowe & Kociolek	Lowe & Kociolek 1984
Neidium levanderi (Hustedt) Lange-Bertalot & Metzeltin	Stoermer et al. 1999
Neidium magellanicum Cleve	Prescott & Dillard 1979
Neidium maximum (Cleve) Meister	Patrick & Reimer 1966
Neidium mirum Krasske	Stoermer et al. 1999
Neidium munckii Foged	Lowe 1972–1973
Neidium productum (W. Smith) Cleve	Stoermer & Kreis 1978
Neidium rudimentarum Reimer	Patrick & Reimer 1966
Neidium sacoense Reimer	Stoermer & Kreis 1978
Neidium temperei Reimer	Stoermer & Kreis 1978
Neidium tenuissimum Hustedt	Johansen et al. 1983
Neidium tumescens (Grunow) Cleve	Boyer 1927b
Nitzschia abbreviata Hustedt	Collins & Kalinsky 1977
Nitzschia abridia Camburn	Camburn 1982
Nitzschia accedens Hustedt	Hohn & Hellerman 1963
Nitzschia accomodata Hustedt	Stoermer & Kreis 1978
Nitzschia acicularioides Hustedt	Stoermer & Kreis 1978
Nitzschia acicularis (Kützing) W. Smith	Stoermer & Kreis 1978
Nitzschia acicularis var. adelos Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia acicularis closterioides Grunow	Czarnecki & Blinn 1978
Nitzschia acida Camburn	Johansen et al. 2004
Nitzschia acidoclinata Lange-Bertalot	Stoermer et al. 1999
Nitzschia actinastroides (Lemmerman) Van Goor	Stoermer & Kreis 1978
Nitzschia acula Hantzsch	Dodd 1987
Nitzschia acuminata (W. Smith) Grunow	Stoermer & Kreis 1978
Nitzschia acuta Hantzsch	Stoermer & Kreis 1978
Nitzschia acutiuscula Grunow	Tempère & Peragallo 1909
Nitzschia adamata Hustedt	Hansmann 1973
Nitzschia adapta Hustedt	Collins & Kalinsky 1977
Nitzschia admissoides Cholnoky	Collins & Kalinsky 1977
Nitzschia aerophila Hustedt	Potapova & Charles 2002
Nitzschia agnewii Cholnoky	Stoermer & Kreis 1978
Nitzschia agnita Hustedt	Collins & Kalinsky 1977
Nitzschia amphibioides Hustedt	Camburn et al. 1978
Nitzschia amphibia Grunow	Stoermer & Kreis 1978
Nitzschia amphibia var. fossilis Grunow	Stoermer & Kreis 1978
Nitzschia amphibia var. frauenfeldii Grunow	Stoermer et al. 1999
Nitzschia amphicephala Grunow	Stoermer & Kreis 1978
Nitzschia amphioxoides Hustedt	Stoermer et al. 1999
Nitzschia amphioxys (Ehrenberg) W. Smith	Stoermer & Kreis 1978
Nitzschia amplectens Hustedt	Camburn 1982
Nitzschia angularis var. affinis Grunow	Benson & Rushforth 1975
Nitzschia angustata (W. Smith) Grunow	Stoermer & Kreis 1978
Nitzschia angustata var. acuta Grunow	Stoermer & Kreis 1978
Nitzschia angustulata Lange-Bertalot	Stoermer et al. 1999
Nitzschia apiculata (Gregory) Grunow	Stoermer & Kreis 1978
Nitzschia archibaldii Lange-Bertalot	Potapova & Charles 2002
Nitzschia aurariae Cholnoky	Potapova & Charles 2002
Nitzschia asymbasia Hohn	Hohn 1961

Name	Publication
Nitzschia bacata Hustedt	Stoermer & Kreis 1978
Nitzschia bacata f. linearis Hustedt	Stoermer & Kreis 1978
Nitzschia bacillariaeformis	Collins & Kalinsky 1977
Nitzschia bacillariaeformis var. producta Cholnoky	Collins & Kalinsky 1977
Nitzschia balcanica Hustedt	Johansen et al. 1983
Nitzschia bella Sovereign	Sovereign 1963
Nitzschia bergii A. Cleve	Czarnecki et al. 1981
Nitzschia biacrula Hohn & Hellerman	Camburn 1982
Nitzschia bicrena Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia bilobata var. ambigua Manguin	Kalinsky 1983
Nitzschia bita Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia brebissonii W. Smith	Boyer 1927b
Nitzschia bremensis Hustedt	Collins & Kalinsky 1977
Nitzschia brevirostris Hustedt	Collins & Kalinsky 1977
Nitzschia brevissima (Grunow) Kalinsky	Camburn 1982
Nitzschia bryophila Hustedt	Reimer 1990
Nitzschia bulnheimiana (Rabenhorst) H.L. Smith	Stoermer & Kreis 1978
Nitzschia bulnheimiana var. capitata Reimer	Reimer 1966
Nitzschia caledonensis Schoeman	Dodd 1987
Nitzschia calida Grunow	Camburn 1982
Nitzschia capitellata Hustedt	Stoermer & Kreis 1978
Nitzschia chasei Cholnoky	Collins & Kalinsky 1977
Nitzschia circumsuta (Bailey) Grunow	Stoermer et al. 1999
Nitzschia clausii Hantzsch	Stoermer & Kreis 1978
Nitzschia closterium (Ehrenberg) W. Smith	Stoermer & Kreis 1978
Nitzschia coarctata Grunow	Camburn 1982
Nitzschia columbiana Sovereign	Sovereign 1958
Nitzschia communis Rabenhorst	Stoermer & Kreis 1978
Nitzschia communis var. abbreviata Grunow	Collins & Kalinsky 1977
Nitzschia communis var. hyalina Lund	Reimer 1970
Nitzschia communis var. obtusa Grunow	Reimer 1961
Nitzschia commutata Grunow	Stoermer & Kreis 1978
Nitzschia compressa (Bailey) Boyer	Collins & Kalinsky 1977
Nitzschia confinis Hustedt	Stoermer & Kreis 1978
Nitzschia congolinensis Hustedt	Wujek & Rupp 1980
Nitzschia congolensis var. mooreae Reimer	Reimer 1982
Nitzschia constricta (Kützing) Ralfs	Camburn 1982
Nitzschia constricta var. subconstricta Grunow	Camburn 1982
Nitzschia debilis Arnott ex Grunow	Camburn 1982
Nitzschia debilis H.L. Smith	H.L. Smith 1876–1888 (#690)
Nitzschia delicatissima Cleve	Stoermer & Kreis 1978
Nitzschia denticula Grunow	Stoermer & Kreis 1978
Nitzschia denticula var. aberrans Fusey	Reimer 1961
Nitzschia desertorum Hustedt	Collins & Kalinsky 1977
Nitzschia diserta Hustedt	Stoermer & Kreis 1978
Nitzschia dissipata (Kützing) Grunow	Stoermer & Kreis 1978
Nitzschia dissipata var. borneensis Hustedt	Stoermer & Kreis 1978
Nitzschia dissipata var. media Grunow	Stoermer & Kreis 1978
Nitzschia dissipata f. undulata Sovereign	Camburn 1982
Nitzschia draveillensis Coste & Ricard	Stoermer et al. 1999
Nitzschia dubia W. Smith	Stoermer & Kreis 1978
Nitzschia elegans Hustedt	Stoermer & Kreis 1978
Nitzschia elegantula Grunow	Camburn 1982
Nitzschia elliptica Hustedt	Collins & Kalinsky 1977
Nitzschia epiphytica Hustedt	Stoermer & Kreis 1978
Nitzschia epiphyticoides Hustedt	Stoermer & Kreis 1978
Nitzschia epithemioides Grunow	Rushforth & Squires 1985

Name	Publication
Nitzschia etoshensis Cholnoky	Collins & Kalinsky 1977
Nitzschia exilis Sovereign	Sovereign 1958
Nitzschia fasciculata Grunow	Stoermer & Kreis 1978
Nitzschia filiformis (W. Smith) Schutt	Stoermer & Kreis 1978
Nitzschia filiformis var. conferta (P.G. Richter) Lange-Bertalot	Stoermer et al. 1999
Nitzschia flexa Schumann	Stoermer & Kreis 1978
Nitzschia fluminenensis Grunow	Stoermer & Kreis 1978
Nitzschia fonticola Grunow	Stoermer & Kreis 1978
Nitzschia fonticola var. capitata A. Cleve	Stoermer & Kreis 1978
Nitzschia fonticula var. pelagica Hustedt	Stoermer & Kreis 1978
Nitzschia fonticola var. romana (Grunow) Cleve-Euler	Whitford & Schumacher 1973
Nitzschia fonticoloides Sovereign	Stoermer & Kreis 1978
Nitzschia frequens Hustedt	Collins & Kalinsky 1977
Nitzschia frustulum (Kützing) Grunow	Stoermer & Kreis 1978
Nitzschia frustulum var. indica	Patrick 1968
Nitzschia frustulum var. minutula	Stoermer et al. 1999
Nitzschia frustulum var. perminuta Grunow	Stoermer & Kreis 1978
Nitzschia frustulum var. perpusilla (Rabenhorst) Grunow	Stoermer & Kreis 1978
Nitzschia frustulum var. subsalina Hustedt	Stoermer & Kreis 1978
Nitzschia frustulum var. subserians	Patrick & Roberts 1979
Nitzschia frustulum var. tenella Grunow	Stoermer & Kreis 1978
Nitzschia gandersheimiensis Krasske	Stoermer & Kreis 1978
Nitzschia geitleri Hustedt	Dodd 1987
Nitzschia gessneri Hustedt	Stoermer et al. 1999
Nitzschia graciliformis Lange-Bertalot & Simonsen	Stoermer et al. 1999
Nitzschia graciloides Hustedt	Stoermer et al. 1999
Nitzschia gracilis Hantzsch	Stoermer & Kreis 1978
Nitzschia gracilis var. minor	Patrick 1968
Nitzschia gracilis var. schizonemoides Van Heurck	Starrett & Patrick 1952
Nitzschia hantzschiana Rabenhorst	Stoermer & Kreis 1978
Nitzschia hantzschiana f. subserians Grunow	Patrick 1945
Nitzschia hennedyi W. Smith	Whitford & Schumacher 1973
Nitzschia heufleuriana Grunow	Stoermer & Kreis 1978
Nitzschia hiemalis Hustedt	Reimer 1961
Nitzschia hollerupensis Foged	Stoermer et al. 1999
Nitzschia holsatica Hustedt	Stoermer & Kreis 1978
Nitzschia homburgiensis Lange-Bertalot	Stoermer et al. 1999
Nitzschia hungarica Grunow	Stoermer & Kreis 1978
Nitzschia hustedtiana Salah	Rushforth et al. 1986
Nitzschia hybrida Grunow	Czarnecki & Blinn 1978
Nitzschia ignorata Krasske	Stoermer & Kreis 1978
Nitzschia impressa Hustedt	Stoermer et al. 1999
Nitzschia incomptus Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia inconspicua Grunow	Stoermer et al. 1999
Nitzschia incurvata var. lorenziana R. Ross	Stoermer et al. 1999
Nitzschia innominata Sovereign	Stoermer et al. 1999
Nitzschia insecta Hustedt	Stoermer & Kreis 1978
Nitzschia intermedia Hantzsch	Stoermer & Kreis 1978
Nitzschia intermissa Hustedt	Collins & Kalinsky 1977
Nitzschia interrupta (Reichelt) Hustedt	Stoermer & Kreis 1978
Nitzschia invisitata Hustedt	Dodd 1971
Nitzschia kittonii H. L. Smith	Hohn & Hellerman 1963
Nitzschia kuetzingiana Hilse	Stoermer & Kreis 1978
Nitzschia kuetzingiana var. exilis Grunow	Stoermer & Kreis 1978
Nitzschia kuetzingioides Hustedt	Stoermer et al. 1999
Nitzschia kurzii Rabenhorst	Collins & Kalinsky 1977
Nitzschia laevis Hustedt	Collins & Kalinsky 1977

Name	Publication
Nitzschia lacunarum Hustedt	Stoermer & Kreis 1978
Nitzschia lacuum Lange-Bertalot	Stoermer et al. 1999
Nitzschia lancettula O. Müller	Sovereign 1958
Nitzschia latens Hustedt	Collins & Kalinsky 1977
Nitzschia lauenburgiana Hustedt	Stoermer & Kreis 1978
Nitzschia lesbia Cholnoky	Collins & Kalinsky 1977
Nitzschia levidensis (W. Smith) Grunow	Camburn 1982
Nitzschia levidensis var. victoriae (Grunow) Cholnoky	Collins & Kalinsky 1977
Nitzschia liebetruthii Rabenhorst	Collins & Kalinsky 1977
Nitzschia linearis (Agardh) W. Smith	Stoermer & Kreis 1978
Nitzschia linearis f. minuta	Cleve & Möller 1879
Nitzschia linearis var. tenuis (Kützing) Grunow	Stoermer & Kreis 1978
Nitzschia littoralis Grunow	Patrick 1961
Nitzschia littoralis var. tergestina Grunow	Czarnecki & Blinn 1978
Nitzschia longissima (Brébisson) Ralfs	Stoermer & Kreis 1978
Nitzschia longissima var. closterium (W. Smith) Van Heurck	Stoermer & Kreis 1978
Nitzschia longissima var. reversa Grunow	Stoermer & Kreis 1978
Nitzschia longissima f. parva Grunow	Stoermer & Kreis 1978
Nitzschia lorenziana Grunow	Stoermer & Kreis 1978
Nitzschia lorenziana var. subtilis Grunow	Camburn 1982
Nitzschia luzonensis Hustedt	Stoermer & Kreis 1978
Nitzschia macilenta Gregory	Stoermer & Kreis 1978
Nitzschia magnacarina Hohn & Hellerman	Collins & Kalinsky 1977
Nitzschia manca Hustedt	Hohn & Hellerman 1963
Nitzschia mediastalsis Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia mediocris Hustedt	Stoermer & Kreis 1978
Nitzschia microcephala Grunow	Stoermer & Kreis 1978
Nitzschia microcephala var. elegantula Grunow	Hohn & Hellerman 1963
Nitzschia migrans Cleve	Collins & Kalinsky 1977
Nitzschia minuta Bleisch	Camburn 1982
Nitzschia minutula Grunow	Stoermer et al. 1999
Nitzschia mollis Hustedt	Collins & Kalinsky 1977
Nitzschia monoensis Kociolek & Herbst	Kociolek & Herbst 1992
Nitzschia montanestris Camburn	Camburn 1982
Nitzschia nana Grunow	Potapova & Charles 2003
Nitzschia nereidis Cholnoky	Collins & Kalinsky 1977
Nitzschia obligata Archibald	Collins & Kalinsky 1977
Nitzschia obsidialis Hustedt	Stoermer & Kreis 1978
Nitzschia obtusa W. Smith	Stoermer & Kreis 1978
Nitzschia obtusa var. brevissima Grunow	Dodd 1981
Nitzschia obtusa var. nana Grunow	Camburn 1982
Nitzschia obtusa var. scalpelliformis Grunow	Stoermer & Kreis 1978
Nitzschia oregana Sovereign	Clark & Rushforth 1977
Nitzschia ovalis Arnott	Collins & Kalinsky 1977
Nitzschia palea (Kützing) W. Smith	Stoermer & Kreis 1978
Nitzschia palea var. debilis (Kützing) Grunow	Patrick 1945
Nitzschia palea var. sumatrana Hustedt	Stoermer & Kreis 1978
Nitzschia palea var. tenuirostris Grunow	Stoermer & Kreis 1978
Nitzschia palea var. tropica Hustedt	Collins & Kalinsky 1977
Nitzschia paleacea Grunow	Stoermer & Kreis 1978
Nitzschia paleaformis Hustedt	Drum 1981
Nitzschia paleoides Hustedt	Stoermer et al. 1999
Nitzschia paradoxa (Gmelin) Grunow	Stoermer & Kreis 1978
Nitzschia parvula W. Smith	Stoermer & Kreis 1978
Nitzschia parvula var. terricola Lund	Collins & Kalinsky 1977
Nitzschia paxillifer (O. F. Müller) Heiberg	Boyer 1927b
Nitzschia perminuta Grunow	Camburn 1982

Name	Publication
Nitzschia perspicillata Camburn	Camburn 1982
Nitzschia perspicua Sovereign	Sovereign 1963
Nitzschia pertica Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia perversa Grunow	Dodd 1987
Nitzschia philippinarum Hustedt	Stoermer et al. 1999
Nitzschia pilum Hustedt	Hansmann 1973
Nitzschia plana W. Smith	Hansmann 1973
Nitzschia plana var. americana Hustedt 1924	Hustedt 1924
Nitzschia planctonica Hustedt	Stoermer et al. 1999
Nitzschia praetexta Nitzsch	Whitford & Schumacher 1973
Nitzschia pseudoamphioxys Hustedt	Stoermer & Kreis 1978
Nitzschia pseudobacata Cholnoky	Collins & Kalinsky 1977
Nitzschia pseudofonticola Hustedt	Collins & Kalinsky 1977
Nitzschia pseudohybrida	Patrick & Roberts 1979
Nitzschia pseudosinuata Hamilton & Laird	Hamilton et al. 2001
Nitzschia pseudostagnorum Hustedt	Kaczmarska & Rushforth 1983
Nitzschia pubens Cholnoky	Collins & Kalinsky 1977
Nitzschia pumila Hustedt	Camburn 1982
Nitzschia punctata (Grunow) Grunow	Rushforth & Merkley 1988
Nitzschia punctata var. elongata Grunow	Rushforth & Merkley 1988
Nitzschia punctata var. peragalli Halden	Patrick 1961
Nitzschia pura Hustedt	Stoermer et al. 1999
Nitzschia pusilla (Kützing) Grunow emend Lange-Bertalot	Camburn 1982
Nitzschia radicula Hustedt	Stoermer et al. 1999
Nitzschia radiosa Kützing	Czarnecki & Blinn 1978
Nitzschia rautenbachiae Cholnoky	Camburn 1982
Nitzschia recta Hantzsch	Stoermer & Kreis 1978
Nitzschia recta var. romana	Collins & Kalinsky 1977
Nitzschia rectiformis Hustedt	Hohn 1961
Nitzschia reimerii Kociolek & Herbst	Kociolek & Herbst 1992
Nitzschia regula Hustedt	Patrick 1961
Nitzschia reversa W. Smith	Camburn 1982
Nitzschia romana Grunow	Stoermer & Kreis 1978
Nitzschia romanoides Manguin	Kalinsky 1983
Nitzschia rostellata Hustedt	Camburn 1982
Nitzschia rufitorrentis Cholnoky	Dodd 1987
Nitzschia scalaris (Ehrenberg) W. Smith	Stoermer & Kreis 1978
Nitzschia scalaris var. undulata Wolle	Tempère & Peragallo 1911
Nitzschia semidesum Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia sentiformis Hohn & Hellerman	Hohn & Hellerman 1963
Nitzschia serpenticula Cholnoky	Collins & Kalinsky 1977
Nitzschia serpentiraphe Lange-Bertalot	Lange-Bertalot 1993
Nitzschia sicula var. migrans (Cleve) Hasle	Stoermer & Kreis 1978
Nitzschia sigma (Kützing) W. Smith	Stoermer & Kreis 1978
Nitzschia sigma var. diminuta Grunow	Stoermer & Kreis 1978
Nitzschia sigma var. rigida (Kützing) Grunow	Stoermer et al. 1999
Nitzschia sigma var. rigidula Grunow	Hohn & Hellerman 1963
Nitzschia sigma var. sigmatella (Gregory) Grunow	Stoermer & Kreis 1978
Nitzschia sigmatella Gregory	Boyer 1927b
Nitzschia sigmaformis Hustedt	Camburn 1982
Nitzschia sigmoidea (Nitzsch) W. Smith	Stoermer & Kreis 1978
Nitzschia silicula Hustedt	Czarnecki et al. 1981
Nitzschia silicula var. commutata Reimer	Reimer 1966
Nitzschia silicula var. migrans	Patrick & Roberts 1979
Nitzschia siliqua Archibald	Collins & Kalinsky 1977
Nitzschia sinuata W. Smith	Stoermer & Kreis 1978
Nitzschia sinuata var. delongnei (Grunow) Lange-Bertalot	Stoermer et al. 1999

Name	Publication
Nitzschia sinuata var. tabellaria (Grunow) Grunow	Stoermer & Kreis 1978
Nitzschia sociabilis Hustedt	Camburn 1982
Nitzschia socialis Gregory	Rushforth & Merkley 1988
Nitzschia solita Hustedt	Potapova & Charles 2002
Nitzschia speciosa Hustedt	Lowe 1972–1973
Nitzschia spectabilis (Ehrenberg) Ralfs	Collins & Kalinsky 1977
Nitzschia spectabilis var. americana Grunow	Boyer 1927b
Nitzschia sphaerophora A. Cleve	Stoermer & Kreis 1978
Nitzschia spiculoides Hustedt	Stoermer & Kreis 1978
Nitzschia spiculum Hustedt	Collins & Kalinsky 1977
Nitzschia stagnicola Rabenhorst	Kalinsky 1983
Nitzschia stagnorum Rabenhorst	Stoermer & Kreis 1978
Nitzschia steynii Cholnoky	Collins & Kalinsky 1977
Nitzschia stricta Hustedt	Collins & Kalinsky 1977
Nitzschia subacicularis Hustedt	Stoermer & Kreis 1978
Nitzschia subamphioxoides Hustedt	Stoermer & Kreis 1978
Nitzschia subcapitellata Hustedt	Stoermer et al. 1999
Nitzschia subconfinis Cholnoky	Reimer 1982
Nitzschia sublinearis Hustedt	Stoermer & Kreis 1978
Nitzschia subrostrata Hustedt	Stoermer & Kreis 1978
Nitzschia subrostratoides Cholnoky	Collins & Kalinsky 1977
Nitzschia subrostroides Cholnoky	Stoermer et al. 1999
Nitzschia subtilis (Kützing) Grunow	Stoermer & Kreis 1978
Nitzschia subtilis var. paleacea Grunow	Stoermer & Kreis 1978
Nitzschia subvitrea Hustedt	Dodd 1987
Nitzschia suchlandtii Hustedt	Potapova & Charles 2002
Nitzschia supralitorea Lange-Bertalot	Potapova & Charles 2003
Nitzschia tabellaria Grunow	Stoermer & Kreis 1978
Nitzschia tarda Hustedt	Stoermer & Kreis 1978
Nitzschia tenuis W. Smith	Stoermer & Kreis 1978
Nitzschia terricola Lund	Camburn et al. 1978
Nitzschia thermalis (Ehrenberg) Auerswald	Stoermer & Kreis 1978
Nitzschia thermalis var. dubia	Collins & Kalinsky 1977
Nitzschia thermalis var. intermedia Grunow	Stoermer & Kreis 1978
Nitzschia thermalis var. minor Hilse	Stoermer & Kreis 1978
Nitzschia tonoensis Foged	Hansmann 1973
Nitzschia tropica Hustedt	Stoermer & Kreis 1978
Nitzschia tryblionella Hantzsch	Stoermer & Kreis 1978
Nitzschia tryblionella var. calida (Grunow) Van Heurck	Hohn & Hellerman 1963
Nitzschia tryblionella var. debilis (Arnott) A. Mayer	Stoermer & Kreis 1978
Nitzschia tryblionella var. levidensis (W. Smith) Grunow	Stoermer & Kreis 1978
Nitzschia tryblionella var. maxima Grunow	Camburn et al. 1978
Nitzschia tryblionella var. salinarum Grunow	Hohn & Hellerman 1963
Nitzschia tryblionella var. victoriae Grunow	Stoermer & Kreis 1978
Nitzschia umbilicata Hustedt	Collins & Kalinsky 1977
Nitzschia umbonata (Ehrenberg) Lange-Bertalot	Dodd 1987
Nitzschia valdestriata Aleem & Hustedt	Camburn 1982
Nitzschia valga Cholnoky	Collins & Kalinsky 1977
Nitzschia vermicularis (Kützing) Grunow	Stoermer & Kreis 1978
Nitzschia vexans Grunow	Stoermer & Kreis 1978
Nitzschia vitrea Norman	Stoermer & Kreis 1978
Nitzschia vitrea var. major	Tempère & Peragallo 1909
Nitzschia vitrea var. recta (Hantzsch) Van Heurck	Tilden 1894–1909 (#94)
Nitzschia vitrea var. scaphiformis Wislough & Poretzky	Dodd 1987
Nitzschia vivax W. Smith	Boyer 1927b
Nitzschia vonhauseniae Cholnoky	Collins & Kalinsky 1977
Nitzschia volcanica Sovereign	Sovereign 1958

Name	Publication
Nitzschia vulga Cholnoky	Stoermer et al. 1999
Nitzschia wipplingeri Cholnoky	Collins & Kalinsky 1977
Nitzschia woltereckii Hustedt	Stoermer & Kreis 1978
Nitzschia zuzulandica Cholnoky	Collins & Kalinsky 1977
Nupela carolina Potapova & Clason 2003	Potapova et al. 2003
Nupela neglecta Ponader, Lowe & Potapova 2003	Potapova et al. 2003
Nupela neotropica Lange-Bertalot in Lange-Bertalot & Moser	Siver et al. 2005
Nupela paludigena (Scherer) Lange-Bertalot	Lange-Bertalot 1993
Nupela vitiosa (Schimanski) Lange-Bertalot	Siver et al. 2005
Nupela wellneri (Lange-Bertalot) Lange-Bertalot	Potapova et al. 2003
Odontella polymorpha	Ehrenberg 1856
Odontidium anceps Ehrenberg	Patrick 1945
Odontidium elongatum (Agardh) Kuntze	Elmore 1922
Odontidium hiemale (Roth) Heiberg	Stoermer & Kreis 1978
Odontidium hiemale var. mesodon (Ehrenberg) Grunow	Patrick 1945
Odontidium mesodon Mutzing	Aubert 1895
Odontidium mutabile W. Smith	Stoermer & Kreis 1978
Odontidium tabellaria Lewis	Aubert 1895
Odontidium vulgare (Bory) Elmore	Elmore 1922
Oestrupia bicontracta (Østrup) Lange-Bertalot & Krammer	Stoermer et al. 1999
Oestrupia zachariasi (Reichelt) Stoermer & Yang	Stoermer & Kreis 1978
Oestrupia zachariasi var. undulata (Schultz) Stoermer & Yang	Stoermer & Kreis 1978
Opephora americana M. Peragallo	Patrick & Reimer 1966
Opephora ansata Hohn & Hellerman	Stoermer & Kreis 1978
Opephora martyi Héribaud	Stoermer & Kreis 1978
Opephora martyi var. capitata (Héribaud) Hustedt	Sovereign 1958
Opephora olsenii Möller	Morales 2001
Opephora pacifica Petit	Prescott & Dillard 1979
Opephora pinnata Ehrenberg	Stoermer & Kreis 1978
Opephora schulzi (Brockmann) Simons	Czarnecki et al. 1981
Opephora swartzii (Grunow) Petit	Prescott & Dillard 1979
??Orthoseira dendroteres (Ehrenberg) Crawford	Gaiser & Johansen 2000
??Orthosira dickiei Thwaites	Stoermer & Kreis 1978
??Orthosira orichalcea	Collins & Kalinsky 1977
??Orthoseira roseana (Rabenhorst) O'Meara	Hamilton et al. 1992
Oxyneis binalis (Ehrenberg) Round in Round et al.	Siver et al. 2005
Peronia fibula (Brébisson ex Kützing) Ross	Patrick & Reimer 1966
Peronia heribaudi Brun ex M. Peragallo in Héribaud	Hamilton et al. 1992
Peronia intermedium (H.L. Smith) Patrick	Patrick & Reimer 1966
Pinnularia abaujensis (Pantocsek) Ross	Stoermer & Kreis 1978
Pinnularia abaujensis var. lacustris Camburn & Charles	Camburn & Charles 2000
Pinnularia abaujensis var. linearis (Hustedt) Patrick	Stoermer & Kreis 1978
Pinnularia abaujensis var. rostrata (Patrick) Patrick	Camburn 1982
Pinnularia abaujensis var. subundulata (A. Mayer) Patrick	Stoermer & Kreis 1978
Pinnularia absita Hohn & Hellerman	Patrick & Reimer 1966
Pinnularia acrosphaeria W. Smith	Stoermer & Kreis 1978
Pinnularia acrosphaeria f. genuina Cleve	Cleve 1895
Pinnularia acrosohaeria var. laevis (M. Peragallo & Héribaud) Cleve	Patrick & Reimer 1966
Pinnularia acrosphaeria var. turgidula Grunow ex Cleve	Camburn 1982

Name	Publication
Pinnularia acuminata W. Smith	Patrick & Reimer 1966
Pinnularia acuminata var. bielawski (Héribaud & Peragallo) Patrick	Collins & Kalinsky 1977
Pinnularia acuminata var. instabilis (A. Schmidt) Patrick	Patrick & Reimer 1966
Pinnularia acuminata var. interrupta (Cleve) Patrick	Patrick & Reimer 1966
Pinnularia acuta	Ehrenberg 1856
Pinnularia aequalis	Ehrenberg 1856
Pinnularia aequilateralis Patrick & Freese	Stoermer 1964
Pinnularia aestuartii Cleve	Krammer 2000
Pinnularia aestuartii var. interrupta (Hustedt) Cleve-Euler	Bateman & Rushforth 1984
Pinnularia affinis	Ehrenberg 1856
Pinnularia alabamae Krammer	Krammer 2000
Pinnularia alpina W. Smith	Krammer 2000
Pinnularia alpina var. elongata (M. Peragallo & Héribaud) Mills	Patrick & Reimer 1966
Pinnularia amblys Hohn & Hellerman	Hohn & Hellerman 1963
Pinnularia amphigomphus	Ehrenberg 1856
Pinnularia amphioxys Ehrenberg	Stoermer & Kreis 1978
Pinnularia amphisbaena	Ehrenberg 1856
Pinnularia amphistylus Ehrenberg	Rushforth & Merkley 1988
Pinnularia anglica Krammer	Gaiser & Johansen 2000
Pinnularia appendiculata (Agardh) Cleve	Boyer 1927b
Pinnularia aquilonaris Hohn & Hellerman	Patrick & Reimer 1966
Pinnularia balfouriana	Patrick & Roberts 1979
Pinnularia biceps Gregory	Stoermer & Kreis 1978
Pinnularia biceps var. minor (Petersen) Cleve-Euler	Rushforth & Merkley 1988
Pinnularia biceps f. petersenii Ross	Stoermer & Kreis 1978
Pinnularia biceps var. pusilla Camburn & Charles	Camburn & Charles 2000
Pinnularia bigibba Gaiser & Johansen	Gaiser & Johansen 2000
Pinnularia bihastata (A. Mann) Patrick	Hansmann 1973
Pinnularia bogotensis (Grunow) Cleve	Boyer 1927b
Pinnularia bogotensis var. undulata (Peragallo) Boyer	Patrick & Reimer 1966
Pinnularia borealis Ehrenberg	Stoermer & Kreis 1978
Pinnularia borealis var. brevicostata Hustedt	Collins & Kalinsky 1977
Pinnularia borealis var. caraccana (Ehrenberg) Brun	Patrick & Reimer 1966
Pinnularia borealis var. congolensis Zanon	Loescher 1981
Pinnularia borealis var. rectangularis Carlson	Stoermer & Kreis 1978
Pinnularia borealis var. scalaris (Ehrenberg) Rabenhorst	Gaiser & Johansen 2000
Pinnularia borealis var. subacuta Ehrenberg	Patrick & Reimer 1966
Pinnularia borealis var. truncata Ehrenberg	Patrick & Reimer 1966
Pinnularia boyeri Patrick	Patrick & Reimer 1966
Pinnularia bramanorum	Ehrenberg 1856
Pinnularia brandelii Cleve	Stoermer & Kreis 1978
Pinnularia brauniana (Grunow ex Schmidt) F.W. Mills	Hamilton et al. 1992
Pinnularia braunii (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia braunii var. amphicephala (A. Mayer) Hustedt	Stoermer & Kreis 1978
Pinnularia braunii var. amphicephala f. subconica Venkataraman	Camburn & Charles 2000
Pinnularia brebissonii (Kützing) Rabenhorst	Stoermer & Kreis 1978
Pinnularia brebissonii f. biundulata O. Müller	Lawson & Rushforth 1975
Pinnularia brebissonii var. diminuta (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia brebissoni var. notata Héribaud & Peragallo	Cleve 1895
Pinnularia brevicostata Cleve	Stoermer & Kreis 1978
Pinnularia brevicostata var. leptostauron Cleve	Tiffany & Britton 1952
Pinnularia burkii Patrick	Stoermer & Kreis 1978
Pinnularia capitata	Ehrenberg 1856
Pinnularia cardinaliculis Cleve	Stoermer & Kreis 1978
Pinnularia cardinalis (Ehrenberg) W. Smith	Stoermer & Kreis 1978
Pinnularia carolinensis	Ehrenberg 1856
Pinnularia castor Hohn & Hellerman	Patrick & Reimer 1966

Name	Publication
Pinnularia caudata (Boyer) Patrick	Camburn 1982
Pinnularia cherryfieldiana Krammer	Krammer 2000
Pinnularia clevei Patrick	Patrick 1945
Pinnularia cocconeis Ehrenberg	Stoermer & Kreis 1978
Pinnularia conspicua (A. Schmidt) Cleve	Patrick & Reimer 1966
Pinnularia convexa Sovereign	Patrick & Reimer 1966
Pinnularia cooperi J.W. Bailey	Ehrenberg 1856
Pinnularia crucifera var. subrostrata A. Cleve	Clark & Rushforth 1977
Pinnularia cumvibia Hohn & Hellerman	Hohn & Hellerman 1963
Pinnularia cuneicephala (Mann) Patrick	Patrick & Reimer 1966
Pinnularia dactylus Ehrenberg	Stoermer & Kreis 1978
Pinnularia dactylus var. dariana (A. Schmidt) Cleve	Boyer 1927b
Pinnularia dactylus var. demerarae Cleve	Boyer 1927b
Pinnularia decurrans Ehrenberg	Patrick & Reimer 1966
Pinnularia dicephala (Ehrenberg) W. Smith	Ehrenberg 1856
Pinnularia digitus	Ehrenberg 1856
Pinnularia disphenia	Ehrenberg 1856
Pinnularia distinguenda Cleve	Stoermer & Kreis 1978
Pinnularia divergens W. Smith	Stoermer & Kreis 1978
Pinnularia divergens var. bacillaris (M. Peragallo) Mills	Stoermer & Kreis 1978
Pinnularia divergens var. decrescens (Grunow) Krammer	Gaiser & Johansen 2000
Pinnularia divergens var. elliptica (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia divergens var. parallela (Brun) Patrick	Camburn 1982
Pinnularia divergens var. schweinfurthii (A. Schmidt) Cleve	Boyer 1927b
Pinnularia divergens var. sublinearis Cleve	Boyer 1927b
Pinnularia divergens var. undulata (M. Peragallo & Héribaud) Hustedt	Patrick & Reimer 1966
Pinnularia divergentissima (Grunow) Cleve	Patrick 1946
Pinnularia divergentissima f. elongata Cleve-Euler	Patrick 1946
Pinnularia divergitissima var. subrostrata A. Cleve	Siver et al. 2005
Pinnularia doloma Hohn & Hellerman	Patrick & Reimer 1966
Pinnularia dubitabilis Hustedt	Czarnecki & Blinn 1978
Pinnularia elliptica	Ehrenberg 1856
Pinnularia elongata Hustedt	Hustedt 1934
Pinnularia episcopalis Cleve	Boyer 1927b
Pinnularia episcopalis var. subelliptica A. Cleve	Lawson & Rushforth 1975
Pinnularia erratica var. fossilis Krammer	Krammer 2000
Pinnularia esox Cleve	Boyer 1927b
Pinnularia esoxiformes Fusey	Gaiser & Johansen 2000
Pinnularia falaiseana Krammer	Gaiser & Johansen 2000
Pinnularia fasciata Lagerstedt	Stoermer & Kreis 1978
Pinnularia ferroindulgentissima Czarnecki & Cawley	Czarnecki & Cawley 1997
Pinnularia flaminula A. Schmidt	Patrick & Reimer 1966
Pinnularia flexuosa Cleve	Boyer 1927b
Pinnularia flexuosa var. cuneata (Tempère & Peragallo) Mills	Patrick & Reimer 1966
Pinnularia flexuosa var. gibbosa Hustedt	Hustedt 1934
Pinnularia fluminea Patrick & Freese	Lowe 1972–1973
Pinnularia formica (Ehrenberg) Patrick	Camburn 1982
Pinnularia fossilis Krammer	Krammer 2000
Pinnularia gastrum	Ehrenberg 1856
Pinnularia gentilis (Donkin) Cleve	Stoermer & Kreis 1978
Pinnularia gibba Ehrenberg	Stoermer & Kreis 1978
Pinnularia gibba f. constricta Skvortzow	Patrick & Reimer 1966
Pinnularia gibba f. curta Rabenhorst	Hohn & Hellerman 1963
Pinnularia gibba var. gibba Hustedt	Hustedt 1934
Pinnularia gibba var. linearis Hustedt	Stoermer & Kreis 1978
Pinnularia gibba var. mesogongyla (Ehrenberg) Hustedt	Reimer 1961
Pinnularia gibba var. parva (Ehrenberg) Grunow	Stoermer & Kreis 1978

Name	Publication
Pinnularia gibba var. rostrata Patrick	Patrick 1945
Pinnularia gibba f. subundulata A. Mayer	Stoermer & Kreis 1978
Pinnularia gibbiformis Krammer	Krammer 2000
Pinnularia gibbiformis var. floralensis Dute & Sullivan	Dute et al. 2000
Pinnularia gigas Ehrenberg	Krammer 2000
Pinnularia globiceps Gregory	Stoermer & Kreis 1978
Pinnularia globiceps var. krockii (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia gracillima Gregory	Patrick & Reimer 1966
Pinnularia gracilis Hustedt	Lowe 1972–1973
Pinnularia hannii Patrick	Patrick 1946
Pinnularia hemiptera Rabenhorst	Stoermer & Kreis 1978
Pinnularia hemiptera var. bielawski Héribaud & Peragallo	Clark & Rushforth 1977
Pinnularia hilseana Janisch	Camburn 1982
Pinnularia inaequalis	Ehrenberg 1856
Pinnularia instita Hohn & Hellerman	Hohn & Hellerman 1963
Pinnularia integra Grunow in Cleve	Cleve 1895
Pinnularia intermedia (Lagerstedt) Cleve	Stoermer & Kreis 1978
Pinnularia interrupta W. Smith	Stoermer & Kreis 1978
Pinnularia interrupta f. bicapitata (Lagerstedt) Fritsch	Patrick & Reimer 1966
Pinnularia interrupta var. crassior (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia interrupta var. sinica Skvortzow	Patrick & Reimer 1966
Pinnularia iridis	Ehrenberg 1856
Pinnularia isostauron (Ehrenberg) Cleve	Patrick & Reimer 1966
Pinnularia isselana Krammer	Siver et al. 2005
Pinnularia kasswingensis	Ehrenberg 1856
Pinnularia karelica Cleve	Drum 1981
Pinnularia kheuckeri Hustedt	Collins & Kalinsky 1977
Pinnularia kriegeriana Krasske emend Foged	Stoermer et al. 1999
Pinnularia krockii (Grunow) Cleve	Stoermer et al. 1999
Pinnularia kwacksii Camburn & Charles	Camburn & Charles 2000
Pinnularia lata (Brébisson) W. Smith	Boyer 1927b
Pinnularia lata var. amplissima Manguin	Camburn 1982
Pinnularia lata var. pachyptera (Ehrenberg) Meister	Patrick & Reimer 1966
Pinnularia lata var. rabenhorstii (Grunow) Cleve	Boyer 1927b
Pinnularia latevittata Cleve	Patrick & Reimer 1966
Pinnularia latevittata var. domingensis Cleve	Stoermer & Kreis 1978
Pinnularia latifascia Patrick	Patrick 1946
Pinnularia legumen (Ehrenberg) Ehrenberg	Stoermer & Kreis 1978
Pinnularia leptogongyla Ehrenberg	Patrick & Reimer 1966
Pinnularia leptosoma (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia leptosoma f. erlangensis A. Mayer	Stoermer & Kreis 1978
Pinnularia leptostigma	Ehrenberg 1856
Pinnularia longa Gregory	Patrick & Reimer 1966
Pinnularia lundii Hustedt	Hohn & Hellerman 1963
Pinnularia macilenta Ehrenberg	Patrick 1946
Pinnularia major (Kützing) Rabenhorst	Stoermer & Kreis 1978
Pinnularia major var. asymmetrica Cleve	Boyer 1927b
Pinnularia major var. capitata Hustedt	Hustedt 1934
Pinnularia major var. heroina (A. Schmidt) Cleve	Patrick & Reimer 1966
Pinnularia major var. hustedti Meister	Hansmann 1973
Pinnularia major var. linearis Cleve	Patrick & Reimer 1966
Pinnularia major var. pulchella Boyer	Boyer 1927b
Pinnularia major var. subacuta (Ehrenberg) Cleve	Patrick & Reimer 1966
Pinnularia maior var. transversa (A. Schmidt) Cleve	Camburn 1982
Pinnularia major var. turgidula Cleve	Patrick & Reimer 1966
Pinnularia makahana Sovereign	Patrick & Reimer 1966
Pinnularia martyi Lauby	Prescott & Dillard 1979

Name	Publication
Pinnularia megaloptera	Ehrenberg 1856
Pinnularia mesogonglya Ehrenberg	Camburn 1982
Pinnularia mesolepta (Ehrenberg) W. Smith	Stoermer & Kreis 1978
Pinnularia mesolepta var. angusta Cleve	Patrick & Reimer 1966
Pinnularia mesolepta var. stauroneiformis (Grunow) Cleve	Patrick & Reimer 1966
Pinnularia mesolepta var. turbulenta Cleve-Euler	Clark & Rushforth 1977
Pinnularia mesotyla Ehrenberg	Patrick & Reimer 1966
Pinnularia microstauron (Ehrenberg) Cleve	Stoermer & Kreis 1978
Pinnularia microstauron var. adirondackensis Camburn & Charles	Camburn & Charles 2000
Pinnularia microstauron var. biundulata O. Müller	Stoermer & Kreis 1978
Pinnularia microstauron var. lunicus Camburn & Charles	Camburn & Charles 2000
Pinnularia microstauron var. nonfasciata Krammer	Krammer 2000
Pinnularia molaris (Grunow) Cleve	Boyer 1927b
Pinnularia molaris var. asiatica Skvortzow	Camburn et al. 1978
Pinnularia montgomeryana Krammer	Krammer 2000
Pinnularia moralis (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia mormonorum (Grunow) Boyer	Boyer 1927b
Pinnularia neglecta (A. Mayer) A. Berg	Reimer 1990
Pinnularia neomajor Krammer	Siver et al. 2005
Pinnularia nobilis (Ehrenberg) W. Smith	Stoermer & Kreis 1978
Pinnularia nodosa (Ehrenberg) W. Smith	Stoermer & Kreis 1978
Pinnularia nodosa var. constricta f. truncata Fusey	Camburn & Charles 2000
Pinnularia nodosa var. pseudogracillima (May) A. Cleve	Clark & Rushforth 1977
Pinnularia nodosa var. robusta (Foged) Krammer	Siver et al. 2005
Pinnularia notabilis Krammer	Gaiser & Johansen 2000
Pinnularia nubila Sovereign	Patrick & Reimer 1966
Pinnularia obscura Krasske	Stoermer & Kreis 1978
Pinnularia obtusa Ehrenberg	Ehrenberg 1856
Pinnularia obtusa Sovereign	Patrick & Reimer 1966
Pinnularia ohiensis Ehrenberg	Ehrenberg 1856
Pinnularia oregonica	Ehrenberg 1856
Pinnularia oxylepta Ehrenberg	Ehrenberg 1856
Pinnularia oxytrachea Ehrenberg	Ehrenberg 1856
Pinnularia palousiana Sovereign	Patrick & Reimer 1966
Pinnularia parallela Brun	Boyer 1927b
Pinnularia parva Gregory	Boyer 1927b
Pinnularia parvula (Ralfs) Cleve-Euler	Patrick & Reimer 1966
Pinnularia paulensis Grunow in Cleve	Boyer 1927b
Pinnularia peregrina	Ehrenberg 1856
Pinnularia permagna J.W. Bailey	Ehrenberg 1856
Pinnularia placentula	Ehrenberg 1856
Pinnularia platycephala f. ornata Sovereign	Patrick & Reimer 1966
Pinnularia platysoma	Ehrenberg 1856
Pinnularia pluviana Sovereign	Krammer 2000
Pinnularia podzorski Krammer	Krammer 2000
Pinnularia pogoii Scherer	Scherer 1988
Pinnularia polyonca (Brébisson) W. Smith	Boyer 1927b
Pinnularia pulchella (Boyer) Krammer	Krammer 2000
Pinnularia pulchra Østrup	Clark & Rushforth 1977
Pinnularia radiosa W. Smith	Stoermer & Kreis 1978
Pinnularia rivularis Hustedt	Patrick & Reimer 1966
Pinnularia rupestris Hantzsch	Stoermer & Kreis 1978
Pinnularia ruttneri Hustedt	Stoermer & Kreis 1978
Pinnularia sabae Ehrenberg	Patrick & Reimer 1966
Pinnularia schweinfurthii (A. Schmidt) Patrick	Patrick & Reimer 1966
Pinnularia secernenda (A. Schmidt) Cleve	Boyer 1927b
Pinnularia semen	Ehrenberg 1856

Name	Publication
Pinnularia semicruciata A. Cleve	Stoermer & Kreis 1978
Pinnularia signata	Ehrenberg 1856
Pinnularia silicula	Ehrenberg 1856
Pinnularia sillimanorum Ehrenberg	Boyer 1927b
Pinnularia singularis (A. Schmidt) Cleve	Patrick & Reimer 1966
Pinnularia sirokiana	Ehrenberg 1856
Pinnularia socialis (T.C. Palmer) Hustedt	Stoermer & Kreis 1978
Pinnularia stauroneis Ehrenberg	Rushforth & Merkley 1988
Pinnularia stauroptera (Grunow) Cleve	Boyer 1927b
Pinnularia stauroptera var. interrupta Cleve	Patrick & Reimer 1966
Pinnularia stauroptera var. semicruciata Cleve	Patrick & Reimer 1966
Pinnularia stomatophora Grunow	Boyer 1927b
Pinnularia stromatophora (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia streptoraphe Cleve	Boyer 1927b
Pinnularia streptoraphe var. muscicola Skvortzow	Reimer 1990
Pinnularia striata	Ehrenberg 1856
Pinnularia stricta Hustedt	Hohn & Hellerman 1963
Pinnularia subanglica Krammer	Siver et al. 2005
Pinnularia subcapitata Gregory	Stoermer & Kreis 1978
Pinnularia subcapitata var. hilseana (Janisch) O. Müller	Collins & Kalinsky 1977
Pinnularia subcapitata var. hybrida (Grunow) Frenguelli	Hohn & Hellerman 1963
Pinnularia subcapitata var. lapponica A. Cleve	Clark & Rushforth 1977
Pinnularia subcapitata var. paucistriata (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia subcapitata var. stauroneiformis Van Heurck	Patrick 1945
Pinnularia subgibba var. gracilis Gaiser & Johansen	Gaiser & Johansen 2000
Pinnularia subgibba var. hustedtii Krammer	Gaiser & Johansen 2000
Pinnularia subgibba var. lanceolata Gaiser & Johansen	Gaiser & Johansen 2000
Pinnularia subgibba var. sublinearis Krammer	Krammer 2000
Pinnularia sublinearis (Grunow) Cleve	Patrick 1945
Pinnularia subnodosa Hustedt	Hustedt 1934
Pinnularia subpalousiana Sovereign	Patrick & Reimer 1966
Pinnularia subrostrata A. Cleve	Stoermer & Kreis 1978
Pinnularia subsolaris (Grunow) Cleve	Sovereign 1958
Pinnularia substomatophora Hustedt	Stoermer & Kreis 1978
Pinnularia sudetica Hilse	Stoermer & Kreis 1978
Pinnularia sudetica var. brittanica (Grunow) Krammer	Krammer 2000
Pinnularia sudetica var. commutata (Grunow) Cleve-Euler	Johansen et al. 1983
Pinnularia suecia	Ehrenberg 1856
Pinnularia superba Cleve-Euler	Clark & Rushforth 1977
Pinnularia tabellaria Ehrenberg	Stoermer & Kreis 1978
Pinnularia tabellaria var. stauroneiformis Van Heurck	Boyer 1927b
Pinnularia tenuis Gregory	Stoermer & Kreis 1978
Pinnularia tenuis var. interrupta (Font.) A. Cleve	Stoermer & Kreis 1978
Pinnularia termes (Ehrenberg) A. Schmidt	Boyer 1927b
Pinnularia termitina (Ehrenberg) Patrick	Stoermer & Kreis 1978
Pinnularia tibetana Hustedt	Stoermer & Kreis 1978
Pinnularia titusiana Hagelstein	Lowe 1972–1973
Pinnularia torta (A. Mann) Patrick	Stoermer & Kreis 1978
Pinnularia transversa (W. Smith) A. Mayer	Gaiser & Johansen 2000
Pinnularia trigonocephala Cleve	Stoermer & Kreis 1978
Pinnularia turfosiphila Gaiser & Johansen	Gaiser & Johansen 2000
Pinnularia turnerae Camburn & Charles	Camburn & Charles 2000
Pinnularia umbrosa Sovereign	Patrick & Reimer 1966
Pinnularia undula (Schumann) Krammer	Krammer 2000
Pinnularia undula var. major (A. Schmidt) Krammer	Krammer 2000
Pinnularia undula var. mesoleptiformis Krammer	Krammer 2000
Pinnularia undulata Gregory	Stoermer & Kreis 1978

Name	Publication
Pinnularia undulata var. subundulata Grunow	Stoermer & Kreis 1978
Pinnularia ventricosa Hustedt	Hustedt 1934
Pinnularia vespa Ehrenberg	Patrick & Reimer 1966
Pinnularia viridiformes Krammer	Gaiser & Johansen 2000
Pinnularia viridis (Nitzsch) Ehrenberg	Stoermer & Kreis 1978
Pinnularia viridis var. commutata (Grunow) Cleve	Stoermer & Kreis 1978
Pinnularia viridis var. caudata Boyer	Boyer 1927b
Pinnularia viridis var. commutata (Grunow) Cleve	Boyer 1927b
Pinnularia viridis var. elliptica Meister	Patrick 1945
Pinnularia viridis var. fallax Cleve	Boyer 1927b
Pinnularia viridis var. minor Cleve	Collins & Kalinsky 1977
Pinnularia viridis var. rupestris (Hantzsch) Cleve	Hohn 1951
Pinnularia viridis var. sudetica (Hilse) Hustedt	Patrick 1945
Pinnularia viridula	Ehrenberg 1856
Pinnularia wisconsinensis Camburn & Charles	Camburn & Charles 2000
Pinnularia woerthensis (A. Mayer) Krammer	Gaiser & Johansen 2000
Placoneis abiskoensis (Hustedt) Lange-Bertalot & Metzeltin	Johansen et al. 2004
Placoneis anglica (Ralfs in Pritchard) Lowe in Johansen et al.	Johansen et al. 2004
Placoneis clementoides (Hustedt) E.J. Cox	Stoermer et al. 1999
Placoneis clementis (Grunow) E.J. Cox	Stoermer et al. 1999
Placoneis dicephala (W. Smith) Mereschkowsky	Stoermer et al. 1999
Placoneis elginensis (Gregory)	Stoermer et al. 1999
Placoneis exigua (Gregory) Mereschkowsky	Stoermer et al. 1999
Placoneis gastrum (Ehrenberg) Mereschkowsky	Stoermer et al. 1999
Placoneis lata (M. Peragallo) Lowe in Johansen et al.	Johansen et al. 2004
Placoneis neglecta (Krasske) Lowe in Johansen et al.	Johansen et al. 2004
Placoneis placentula (Ehrenberg) Heinzerling	Stoermer et al. 1999
Placoneis placentula f. rostrata (Mayer) Bukhtiyarova	Stoermer et al. 1999
Placoneis placentula var. rostrata (A. Mayer) Andresen et al.	Andresen et al. 2000
Plagiotropis arizonica Czarnecki & Blinn	Czarnecki et al. 1981
Plagiotropis lepidoptera (Gregory) Reimer	Stoermer et al. 1999
Plagiotropis lepidoptera var. proboscidea (Cleve) Reimer	Camburn 1982
Plagiotropis vitrea (W. Smith) Grunow	Rushforth & Squires 1985
Plagiotropis vitrea var. scaligera (Grunow ex Cleve & Grunow) Peragallo	Rushforth & Squires 1985
Planothidium apiculatum (Patrick) Lowe in Johansen et al.	Johansen et al. 2004
Planothidium calcar (Cleve) Bukhtiyarova & Round	Stoermer et al. 1999
Planothidium delicatulum (Kützing) Round & Bukhtiyarova	Stoermer et al. 1999
Planothidium dubium (Grunow) Round & Bukhtiyarova	Stoermer et al. 1999
Planothidium ellipticum (A. Cleve) Round & Bukhtiyarova	Stoermer et al. 1999
Planothidium fossile (Tempère & Peragallo) Lowe in Johansen et al.	Johansen et al. 2004
Planothidium frequentissimum (Lange-Bertalot) Round & Bukhtiyarova	Siver et al. 2005
Planothidium hauckianum (Grunow) Round & Bukhtiyarova	Stoermer et al. 1999
Planothidium hauckianum var. rostratum (Schulz) Andresen et al.	Andresen et al. 2000
Planothidium lanceolatum (Brébisson) Round & Bukhtiyarova	Stoermer et al. 1999
Planothidium lanceolatum var. bimaculatum (Hustedt) Andresen et al.	Andresen et al. 2000
Planothidium lanceolatum var. genuinum (A. Mayer) Andresen et al.	Andresen et al. 2000
Planothidium lanceolatum var. omissum (Reimer) Andresen et al.	Andresen et al. 2000
Planothidium oestrupii (H. Bachmann & A. Cleve) Round & Bukhtiyarova	Stoermer et al. 1999
Planothidium peragallii (Brun & Héribaud) Round & Bukhtiyarova	Stoermer et al. 1999
Planothidium peragalli var. fossilum (Tempère & Peragallo) Andresen et al.	Andresen et al. 2000
Planothidium peragalli var. parvulum (Patrick) Andresen et al..	Andresen et al. 2000
Playaensis circumfimbriata Spaulding & Kociolek	Spaulding et al. 2002
Playaensis furtiva Spaulding & Kociolek	Spaulding et al. 2002

Name	Publication
Pleurosira laevis (Ehrenberg) Compère	Stoermer et al. 1999
Pleurosigma acuminatum (Kützing) Grunow	Stoermer & Kreis 1978
Pleurosgima angulatum (Quekett) W. Smith	Dodd 1987
Pleurosigma attenuatum W. Smith	Stoermer & Kreis 1978
Pleurosigma australe Grunow	Patrick & Reimer 1966
Pleurosigma boyeri Keeley	Keeley 1926
Pleurosigma delicatulum W. Smith	Stoermer & Kreis 1978
Pleurosigma delicatulum var. americana Cleve	Patrick & Reimer 1966
Pleurosigma elongatum W. smith	Patrick & Reimer 1966
Pleurosigma eximium (Thwaites) Cleve & Grunow	Stoermer & Kreis 1978
Pleurosigma fasciolata W. Smith	Ehrenberg 1856
Pleurosigma formosum	Sterrenburg 1991
Pleurosigma kuetzingii Grunow	Stoermer & Kreis 1978
Pleurosigma normani	Patrick & Reimer 1966
Pleurosigma obscurum W. Smith	Stoermer & Kreis 1978
Pleurosigma obtusatum Sullivant & Wormley	Collins & Kalinsky 1977
Pleurosigma paradoxum Peragallo	Patrick & Reimer 1966
Pleurosigma salinarum Grunow	Potapova & Charles 2002
Pleurosigma salinarum var. boyeri (Keeley) Reimer	Patrick & Reimer 1966
Pleurosigma scalprum Grunow	Cleve & Möller 1879
Pleurosigma sciotense Sullivan	Stoermer & Kreis 1978
Pleurosigma spencerii Grunow	Stoermer & Kreis 1978
Pleurosigma spenceri (Quekett) W. Smith	Tilden 1894–1909 (#90)
Pleurosigma strigosum W. Smith	Patrick & Reimer 1966
Pleurosigma wansbeckii Donkin	Cleve & Möller 1879
Pleurosigma wormleyi Sullivan	Stoermer & Kreis 1978
Pleurostauron acuta Rabenhorst	Tempère & Peragallo 1909
Pleurostauron acuta var. robusta	Tempère & Peragallo 1909
Pleurostauron javanica Grunow	Tempère & Peragallo 1911
Pleurostauron smithii Grunow	Tempère & Peragallo 1911
Psammothidium abundans f. rosenstockii (Lange-Bertalot) Bukhtiyarova	Stoermer et al. 1999
Psammothidium altaicum (Poretzky) Bukhtiyarova & Round	Stoermer et al. 1999
Psammothidium bioreti (Germain) Bukhtiyarova & Round	Stoermer et al. 1999
Psammothidium daonense (Lange-Bertalot) Lange-Bertalot	Siver et al. 2005
Psammothidium didymum (Hustedt) Bukhtiyarova & Round	Stoermer et al. 1999
Psammothidium helveticum (Hustedt) Bukhtiyarova	Potapova & Charles 2002
Psammothidium lauenburgianum (Hustedt) Round & Bukhtiyarova	Potapova & Charles 2003
Psammothidium levanderi (Hustedt) Bukhtiyarova & Round	Stoermer et al. 1999
Psammothidium marginulatum (Grunow) Bukhtiyarova & Round	Stoermer et al. 1999
Psammothidium sacculum (Carter) Bukhtiyarova in Bukhtiyarova & Round	Siver et al. 2005
Psammothidium subatomoides (Hustedt) Bukhtiyarova & Round	Stoermer et al. 1999
Psammothidium ventralis (Krasske) Bukhtiyarova & Round	Stoermer et al. 1999
Pseudoeunotia lunaris Ehrenberg	Stoermer & Kreis 1978
Pseudostaurosira brevistriata (Grunow in Van Heurck) Williams & Round	Stoermer et al. 1999
Pseudostaurosira brevistriata var. binodis (Pantocsek) Andresen et al.	Andresen et al. 2000
Pseudostaurosira brevistriata var. capitata (Héribaud) Andresen et al.	Andresen et al. 2000
Pseudostaurosira brevistriata var. inflata (Pantocsek) Edlund	Stoermer et al. 1999
Pseudostaurosira clavatum Morales	Morales 2002
Pseudostaurosira construens var. binodis	Stoermer et al. 1999
Pseudostaurosira neoelliptica (Witkowski) Morales	Morales 2002
Pseudostaurosira parasitica (W. Smith) Morales	Morales 2003
Pseudostaurosira parasitica var. subconstricta (Grunow) Morales	Morales 2003

Name	Publication
Pseudostaurosira pseudoconstruens (Marciniak) Williams & Round	Morales 2001
Pseudostaurosira trainorii Morales	Morales 2001
Pseudostaurosiropsis connecticutensis Morales	Morales 2001
Pseudostaurosiropsis geocollegarum (Witkowski & Lange-Bertalot) Morales	Morales 2002
Reimeria sinuata (Gregory) Kociolek & Stoermer	Stoermer et al. 1999
Reimeria sinuata f. antiqua (Gregory) Kociolek & Stoermer	Stoermer et al. 1999
Rhizosolenia eriensis H.L. Smith	Stoermer & Kreis 1978
Rhizosolenia eriensis var. morsa West & West	Gaufin et al. 1976
Rhizosolenia eriensis var. pusilla Wolosz. In Schroeder	Stoermer et al. 1999
Rhizosolenia eriensis var. zachariasi (Brun) Playfair	Stoermer et al. 1999
Rhizosolenia gracilis H.L. Smith	Stoermer & Kreis 1978
Rhizosolenia longiseta Zacharias	Stoermer & Kreis 1978
Rhizosolenia minima Levan	Czarnecki et al. 1981
Rhizosolenia rothii (Ehrenberg) Grunow	Prescott & Dillard 1979
Rhizosolenia stagnalis Zacharias	Prescott & Dillard 1979
Rhoicosphenia curvata (Kützing) Grunow	Stoermer & Kreis 1978
Rhoicosphenia curvata var. gracilis	Tempère & Peragallo 1912
Rhoicosphenia curvata var. major Cleve	Sovereign 1958
Rhoicosphenia curvata var. minor	Patrick 1968
Rhoicosphenia curvata var. subacuta M. Schmidt	Stoermer & Kreis 1978
Rhopalodia argus W. Smith	Stoermer & Kreis 1978
Rhopalodia brebissonii Krammer	Gaiser & Johansen 2000
Rhopalodia gibba (Ehrenberg) O. Müller	Stoermer & Kreis 1978
Rhopalodia gibba var. parallela (Ehrenberg) O. Müller	Reimer 1961
Rhopalodia gibba var. ventricosa (Kützing) Peragallo & Peragallo	Stoermer & Kreis 1978
Rhopalodia gibberula (Ehrenberg) O. Müller	Stoermer & Kreis 1978
Rhopalodia gibberula var. producta (Grunow) O. Müller	Patrick & Reimer 1975
Rhopalodia gibberula var. protracta Grunow	Patrick & Reimer 1975
Rhopalodia gibberula var. rupestris (W. Smith) O. Müller	Patrick & Reimer 1975
Rhopalodia gibberula var. vanheurckii O. Müller	Camburn 1982
Rhopalodia musculus (Kützing) O. Müller	Camburn 1982
Rhopalodia musculus var. constricta (Brébisson) Peragallo & Peragallo	Rushforth & Merkley 1988
Rhopalodia parallela (Grunow) O. Müller	Stoermer & Kreis 1978
Rhopalodia ventricosa (Kützing) Østrup	Prescott & Dillard 1979
Rossithidium linearis (W. Smith) Round & Bukhtiyarova	Stoermer et al. 1999
Rossithidium pusillum (Grunow) Round & Bukhtiyarova	Stoermer et al. 1999
Rouxia californica var. minuta A. Cleve	Stoermer & Kreis 1978
Sarcophagodes delicatula Morales 2002	Morales 2002
Sceptroneis fibula (Brébisson) Schutt	Elmore 1922
Sceptroneis pacifica (Grunow) Elmore	Collins & Kalinsky 1977
Schizonema viridulum Brébisson	Stoermer & Kreis 1978
Schizonema vulgare Thwaites	Stoermer & Kreis 1978
Scoliopleura campylogramma (Ehrenberg) Rabenhorst	Stoermer et al. 1999
Scoliopleura peisonis Grunow	Patrick & Reimer 1966
Scoliopleura tumida (Brébisson) Rabenhorst	Elmore 1922

Name	Publication
Sellaphora americana (Ehrenberg) D.G. Mann	Stoermer et al. 1999
Sellaphora bacilarioides (Grunow) Andresen et al.	Andresen et al. 2000
Sellaphora bacilliformis (Grunow) Mereschkowsky	Stoermer et al. 1999
Sellaphora bacillum (Ehrenberg) D.G. Mann	Stoermer et al. 1999
Sellaphora disjuncta (Hustedt) D.G. Mann	Hamilton et al. 1992
Sellaphora laevissima (Kützing) D.G. Mann	Stoermer et al. 1999
Sellaphora mutata (Krasske) Lange-Bertalot	Stoermer et al. 1999
Sellaphora nyassensis (O. Müller) D.G. Mann	Stoermer et al. 1999
Sellaphora nyassensis f. minor (O. Müller) Andresen et al.	Andresen et al. 2000
Sellaphora parapupula Lange-Bertalot	Stoermer et al. 1999
Sellaphora pupula (Kützing) Mereschkowsky	Stoermer et al. 1999
Sellaphora pupula var. elliptica (Hustedt) Poulin	Stoermer et al. 1999
Sellaphora pupula var. mutata (Krasske) Poulin	Stoermer et al. 1999
Sellaphora pupula f. rostrata (Hustedt) Bukhtiyarova	Stoermer et al. 1999
Sellaphora pupula var. rectangularis (Gregory) Mereschkowsky	Stoermer et al. 1999
Sellaphora rectangularis (Gregory) Lange-Bertalot & Metzeltin	Stoermer et al. 1999
Sellaphora rostrata (Hustedt) Johansen in Johansen et al.	Johansen et al. 2004
Sellaphora seminulum (Grunow) D.G. Mann	Stoermer et al. 1999
Sellaphora wummensis Johansen in Johansen et al.	Johansen et al. 2004
Sellaphora vitabunda (Hustedt) D.G. Mann	Stoermer et al. 1999
Semiorbis hemicyclus (Ehrenberg) Patrick	Patrick & Reimer 1966
Simonsenia delongei (Grunow) Lange-Bertalot	Potapova & Charles 2002
Skeletonema costatum (Greville) Cleve	Stoermer & Kreis 1978
Skeletonema potamos (Weber) Hasle	Stoermer & Kreis 1978
Skeletonema subsalsum (A. Cleve) Bethge	Stoermer & Kreis 1978
Sphinctocystis elliptica (Kützing) Kuntze	Stoermer & Kreis 1978
Sphinctocystis librilis (Ehrenberg) Hassal	Stoermer & Kreis 1978
Stauroforma exiguiformis (Lange-Bertalot) Flower	Morales 2001
Stauroforma inermis Flower, Jones & Round	Morales 2001
Stauroneis acuta W. Smith	Stoermer & Kreis 1978
Stauroneis acuta var. major	Tempère & Peragallo 1909
Stauroneis acuta var. terryana Tempère ex Cleve	Patrick & Reimer 1966
Stauroneis acutiuscula M. Peragallo & Héribaud	Stoermer & Kreis 1978
Stauroneis agrestris Peterson	Stoermer & Kreis 1978
Stauroneis alabamae Heiden	Stoermer & Kreis 1978
Stauroneis alabamae var. angulata Heiden	Hohn 1951
Stauroneis alabamae var. rostrata Heiden	Heiden 1903
Stauroneis americana Heiden	Boyer 1927b
Stauroneis amphilepta Ehrenberg	Patrick & Reimer 1966
Stauroneis amphioxys Gregory	Stoermer & Kreis 1978
Stauroneis amphioxys var. obtusa Hendey	Kalinsky 1983
Stauroneis anceps Ehrenberg	Stoermer & Kreis 1978
Stauroneis anceps var. americana Reimer	Stoermer & Kreis 1978
Stauroneis anceps var. amphicephala (Kützing) Cleve	Patrick 1945
Stauroneis anceps var. birostris (Ehrenberg) Cleve	Patrick & Reimer 1966
Stauroneis anceps var. capitata M. Peragallo	Tempère & Peragallo 1908
Stauroneis anceps var. elongata Tempère & Peragallo	Tempère & Peragallo 1911
Stauroneis anceps var. fossilis Cleve	Tempère & Peragallo 1912
Stauroneis anceps var. gracilis (Ehrenberg) Brun	Patrick 1945
Stauroneis anceps var. hyalina Brun & M. Peragallo	Stoermer & Kreis 1978
Stauroneis anceps var. linearis (Ehrenberg) Van Heurck	Patrick 1945

Name	Publication
Stauroneis anceps var. nobilis	Tempère & Peragallo 1909
Stauroneis anceps var. prominula Grunow	Hohn 1951
Stauroneis anceps var. siberica Grunow	Stoermer & Kreis 1978
Stauroneis anceps var. subrostrata Gaiser & Johansen	Gaiser & Johansen 2000
Stauroneis anceps f. gracilis Rabenhorst	Stoermer & Kreis 1978
Stauroneis anceps f. linearis (Ehrenberg) Hustedt	Stoermer & Kreis 1978
Stauroneis arctica A. Cleve	Bateman & Rushforth 1984
Stauroneis baileyi Ehrenberg	Boyer 1927b
Stauroneis baconiana Stodder	Boyer 1927b
Stauroneis binodis Ehrenberg	Patrick & Reimer 1966
Stauroneis birostris Ehrenberg	Patrick & Reimer 1966
Stauroneis borrichii (Petersen) Lund	Dodd 1987
Stauroneis borrichii f. subcapitata Peterson	Collins & Kalinsky 1977
Stauroneis bovbjergii Reimer	Reimer 1990
Stauroneis brunii M. Peragallo & Heribuad	Tempère & Peragallo 1913
Stauroneis crucicula (Grunow) Boyer	Boyer 1927b
Stauroneis dicephala Ehrenberg	Patrick & Reimer 1966
Stauroneis dilatata Ehrenberg	Stoermer & Kreis 1978
Stauroneis dilatata f. baicalensis Skvortzow & Meyer	Stoermer & Kreis 1978
Stauroneis euglypta Ehrenberg	Patrick & Reimer 1966
Stauroneis eurysoma Ehrenberg	Patrick & Reimer 1966
Stauroneis fenestra Ehrenberg	Patrick & Reimer 1966
Stauroneis fluminea Patrick & Freese	Stoermer & Kreis 1978
Stauroneis frickei var. angusta Boyer	Boyer 1927b
Stauroneis gallica M. Peragallo	Patrick & Reimer 1966
Stauroneis gracilior (Rabenhorst) Reichardt	Siver et al. 2005
Stauroneis gracilis Ehrenberg	Stoermer & Kreis 1978
Stauroneis gregorii Ralfs	Stoermer & Kreis 1978
Stauroneis ignorata Hustedt	Collins & Kalinsky 1977
Stauroneis ignorata var. rupestris (Skvortzow) Reimer	Hansmann 1973
Stauroneis javanica Grunow	Cleve 1894
Stauroneis kriegeri Patrick	Stoermer & Kreis 1978
Stauroneis kriegeri f. undulata Hustedt	Stoermer & Kreis 1978
Stauroneis lanceolata Kützing	Tempère & Peragallo 1911
Stauroneis lauenburgiana Hustedt	Stoermer & Kreis 1978
Stauroneis legleri Hustedt	Kaczmarska & Rushforth 1983
Stauroneis legumen (Ehrenberg) Kützing	Boyer 1927b
Stauroneis linearis Ehrenberg	Stoermer & Kreis 1978
Stauroneis lineolata Ehrenberg	Patrick & Reimer 1966
Stauroneis livingstonii Reimer	Stoermer & Kreis 1978
Stauroneis lundii Hustedt	Clark & Rushforth 1977
Stauroneis macrocephala Kützing	Patrick & Reimer 1966
Stauroneis maculata	Ehrenberg 1856
Stauroneis montana Krasske	Collins & Kalinsky 1977
Stauroneis muriella f. linearis Lund	Rushforth & Squires 1985
Stauroneis nana Hustedt	Patrick & Reimer 1966
Stauroneis neohyalina Lange-Bertalot	Stoermer et al. 1999
Stauroneis nobilis Schumann	Patrick & Reimer 1966
Stauroneis nobilis var. alabamae (Heiden) Cleve-Euler	Camburn 1982
Stauroneis nobilis var. baconiana (Stodder) Reimer	Stoermer & Kreis 1978
Stauroneis nobilis var. gracilis Kobayasi	Camburn & Charles 2000
Stauroneis norvegica Hustedt	Patrick & Reimer 1966
Stauroneis obtusa Lagerstedt	Stoermer & Kreis 1978
Stauroneis obtusa var. catarinensis Krasske	Dodd 1987
Stauroneis palustris Hustedt	Drum 1981
Stuaroneis parvula (Grunow) Cleve	Boyer 1927b
Stauroneis phoenicenteron (Nitzsch) Ehrenberg	Stoermer & Kreis 1978

Name	Publication
Stauroneis phoenicenteron var. amphilepta (Ehrenberg) Cleve	Tiffany & Britton 1952
Stauroneis phoenicenteron var. baileyi Ehrenberg	Cleve 1894
Stauroneis phoenicenteron var. brevis Dippel	Stoermer & Kreis 1978
Stauroneis phoenicenteron var. brunii (Peragallo & Héribaud) Voigt	Collins & Kalinsky 1977
Stauroneis phoenicenteron var. genuina Cleve	Cleve 1894
Stauroneis phoenicenteron f. gracilis (Ehrenberg) Hustedt	Stoermer & Kreis 1978
Stauroneis phoenicenteron var. intermedia (Dippel) A. Cleve	Stoermer et al. 1999
Stauroneis phoenicenteron f. lanceolata (Kützing) Brun	Stoermer & Kreis 1978
Stauroneis phoenicenteron f. linearis (Ehrenberg) Hustedt	Reimer 1990
Stauroneis phyllodes Ehrenberg	Stoermer & Kreis 1978
Stauroneis platalea Ehrenberg	Patrick & Reimer 1966
Stauroneis platysoma Ehrenberg	Kalinsky 1983
Stauroneis producta Grunow	Stoermer & Kreis 1978
Stauroneis pteroidea Ehrenberg	Tempère & Peragallo 1908
Stauroneis pulchella W. Smith	Tilden 1894–1909 (#367)
Stauroneis pygmaea Krieger	Dodd 1981
Stauroneis quadrata M. Peragallo & Héribaud	Tempère & Peragallo 1909
Stauroneis schinzii (Brun) Cleve	Boyer 1927b
Stauroneis semen Ehrenberg	Stoermer & Kreis 1978
Stauroneis siberica (Grunow) Lange-Bertalot	Stoermer et al. 1999
Stauroneis sieboldii Ehrenberg	Patrick & Reimer 1966
Stauroneis smithii Grunow	Stoermer & Kreis 1978
Stauroneis smithii var. borgei Ehrenberg	Stoermer et al. 1999
Stauroneis smithii var. incisa Pantocsek	Camburn 1982
Stauroneis smithii var. minima Haworth	Stoermer & Kreis 1978
Stauroneis staurolineata Reimer	Patrick & Reimer 1966
Stauroneis stodderi Greenleaf in Lewis	Stoermer & Kreis 1978
Stauroneis subula	Ehrenberg 1856
Stauroneis tenera Hustedt	Hohn & Hellerman 1963
Stauroneis terryi Ward in Palmer	Boyer 1927b
Stauroneis thermicola (Petersen) Lund	Dodd 1987
Stauroneis triundulatum Borge	Patrick & Reimer 1966
Stauroneis virginica	Ehrenberg 1856
Stauroneis wislouchii Poretzky & Anisimata	Grimes & Rushforth 1982
Staurophora amphioxys (Gregory) D.G. Mann	Stoermer et al. 1999
Stauroptera aspera	Ehrenberg 1856
Stauroptera isostauron	Ehrenberg 1856
Stauroptera legumen	Ehrenberg 1856
Stauroptera microstauron	Ehrenberg 1856
Stauroptera parva	Ehrenberg 1856
Stauroptera trinodis	Ehrenberg 1856
Staurosira brevistriata Grunow	Stoermer & Kreis 1978
Staurosira capucina Borzsc.	Stoermer & Kreis 1978
Staurosira construens Ehrenberg	Williams & Round 1987
Staurosira construens var. binodis (Ehrenberg) Hamilton in Hamilton et al.	Hamilton et al. 1992
Staurosira construens var. capitata (Héribaud) Andresen et al.	Andresen et al. 2000
Staurosira construens var. minuta (Tempère & Peragallo) Andresen et al.	Andresen et al. 2000
Staurosira construens f. subsalina (Hustedt) Andresen et al.	Andresen et al. 2000
Staurosira construens var. venter (Ehrenberg) Hamilton	Stoermer et al. 1999
Staurosira elliptica (Schumann) Wiliams & Round	Morales 2001
Staurosira entomon Ehrenberg	Stoermer & Kreis 1978
Staurosira leptostauron var. dubia (Grunow) Edlund	Stoermer et al. 1999
Staurosira mutabilis (W. Smith) Grunow	Stoermer & Kreis 1978
Staurosira pinnata	Ehrenberg 1856

Name	Publication
Staurosira stevensonii Manoylov, Morales & Stoermer	Manoylov et al. 2003
Staurosira venter (Ehrenberg) Grunow in Pantocsek	Siver et al. 2005
Staurosirella berolinensis (Lemmerman) Edlund	Morales 2002
Staurosirella lapponica (Grunow in Van Heurck) Williams & Round	Stoermer et al. 1999
Staurosirella leptostauron (Ehrenberg) Williams & Round	Stoermer et al. 1999
Staurosirella leptostauron var. dubia (Grunow) Bukhtiyarova	Morales 2002
Staurosirella leptostauron var. fossilis (Pantocsek) Andresen et al.	Andresen et al. 2000
Staurosirella leptostauron var. rhomboides (Grunow) Andresen et al.	Andresen et al. 2000
Staurosirella pinnata (Ehrenberg) Williams & Round	Williams & Round 1987
Staurosirella pinnata var. intercedens (Grunow in Van Heurck) Hamilton	Stoermer et al. 1999
Staurosirella pinnate var. lancettula (Schumann) Siver & Hamilton in Siver et al.	Siver et al. 2005
Staurosirella trigona (Brun & Héribaud) Siver & Hamilton in Siver et al.	Siver et al. 2005
Stenopterobia anceps (Lewis) Brébisson	Stoermer et al. 1999
Stenopterobia anceps f. subacuta Fricke	Hustedt 1912
Stenopterobia curvula (W. Smith) Krammer	Dute et al. 2000
Stenopterobia delicatissima (Lewis) Brébisson	Dute et al. 2000
Stenopterobia densestriata (Hustedt) Krammer	Gaiser & Johansen 2000
Stenopterobia intermedia (Lewis) Fricke	Stoermer & Kreis 1978
Stenopterobia intermedia f. densistriata Hustedt	Whitford & Schumacher 1973
Stenopterobia intermedia f. subacuta Fricke	Camburn 1982
Stenopterobia intermedia f. undulata Sovereign	Sovereign 1963
Stenopterobia rautenbachiae	Patrick & Roberts 1979
Stephanodiscus alpinus Hustedt	Stoermer & Kreis 1978
Stephanodiscus astraea (Ehrenberg) Grunow	Stoermer & Kreis 1978
Stephanodiscus astraea var. intermedia Fricke	Stoermer & Kreis 1978
Stephanodiscus astraea var. minutula Grunow	Stoermer & Kreis 1978
Stephanodiscus astraea var. minutulus (Kützing) Grunow	Stoermer & Kreis 1978
Stephanodiscus astraea var. spinulosa	Tempère & Peragallo 1909
Stephanodiscus barkleyi Rattray	Whitford 1956
Stephanodiscus binatus Håkansson & Kling	Siver et al. 2005
Stephanodiscus binderanus (Kützing) Kreiger	Stoermer & Kreis 1978
Stephanodiscus binderanus var. oestrupii (A. Cleve) A. Cleve	Stoermer & Kreis 1978
Stephanodiscus carconensis Grunow	Stoermer & Kreis 1978
Stephanodiscus carconensis var. minor	Tempère & Peragallo 1912
Stephanodiscus carconensis var. pusilla Grunow	Stoermer & Kreis 1978
Stephanodiscus conspicueporus Stoermer, Håkansson & Theriot	Stoermer et al. 1999
Stephanodiscus dubius (Fricke) Hustedt	Stoermer & Kreis 1978
Stephanodiscus excentricus Hustedt	Kociolek & Herbst 1992
Stephanodiscus hantzschii Grunow	Stoermer & Kreis 1978
Stephanodiscus hantzschii var. delicatula Cleve	Whitford & Schumacher 1973
Stephanodiscus hantzschii f. tenuis (Hustedt) Håkansson & Stoermer	Stoermer et al. 1999
Stephanodiscus hantzschii var. pusilla Grunow	Stoermer & Kreis 1978
Stephanodiscus invisitatus Hohn & Hellerman	Stoermer & Kreis 1978
Stephanodiscus kuetzingiana (nomen nudum)	Stoermer & Kreis 1978
Stephanodiscus lucens Hustedt	Stoermer et al. 1999
Stephanodiscus medius Håkansson	Stoermer et al. 1999
Stephanodiscus minutula (Kützing) Round	Stoermer et al. 1999
Stephanodiscus minutulus (Kützing) Cleve & Möller	Stoermer et al. 1999
Stephanodiscus minutus Grunow	Stoermer & Kreis 1978
Stephanodiscus niagarae Ehrenberg	Stoermer & Kreis 1978
Stephanodiscus niagarae var. magnifica Fricke	Stoermer & Kreis 1978
Stephanodiscus parvus Stoermer & Håkansson	Stoermer et al. 1999
Stephanodiscus reimerii Theriot & Stoermer	Theriot 1992
Stephanodiscus rotula (Kützing) Hendey	Stoermer & Kreis 1978

Name	Publication
Stephanodiscus rotula var. minutula (Kützing) Grunow	Stoermer & Kreis 1978
Stephanodiscus subsalsus (A. Cleve) Hustedt	Stoermer & Kreis 1978
Stephanodiscus subtilis (Van Goor) A. Cleve	Stoermer & Kreis 1978
Stephanodiscus subtransilvanicus Gasse	Stoermer et al. 1999
Stephanodiscus superiorensis Stoermer & Theriot	Stoermer et al. 1999
Stephanodiscus tenuis Hustedt	Stoermer & Kreis 1978
Stephanodiscus transylvanicus Pantocsek	Stoermer & Kreis 1978
Stephanodiscus vestibulis Håkansson, Stoermer & Theriot	Stoermer et al. 1999
Stephanodiscus yellowstonensis Theriot & Stoermer	Therior & Stoermer 1984
Stephanosira mississippica	Ehrenberg 1856
Striatella fenestrata (Lyngbye) Kuntze	Stoermer & Kreis 1978
Striatella flocculosa (Roth) Kuntze	Stoermer & Kreis 1978
Surirella acredula Hohn & Hellerman	Hohn & Hellerman 1963
Surirella adumbratus Hohn & Hellerman	Hohn & Hellerman 1963
Surirella agmatilis Camburn	Camburn 1982
Surirella alicula Hohn & Hellerman	Collins & Kalinsky 1977
Surirella amphioxys W. Smith	Stoermer & Kreis 1978
Surirella anceps Lewis	Stoermer & Kreis 1978
Surirella angusta Kützing	Stoermer & Kreis 1978
Surirella apiculata W. Smith	Stoermer & Kreis 1978
Surirella arcta A. Schmidt	Tempère & Peragallo 1909
Surirella arctissima A. Schmidt	Boyer 1927b
Surirella baileyi Lewis	Boyer 1927b
Surirella barca Hohn & Hellerman	Hohn & Hellerman 1963
Surirella beadensis Sovereign	Sovereign 1963
Surirella bifrons Ehrenberg	Stoermer & Kreis 1978
Surirella birostrata Hustedt	Stoermer & Kreis 1978
Surirella biseriata Brébisson & Godey	Stoermer & Kreis 1978
Surirella biseriata var. bifrons (Ehrenberg) Hustedt	Stoermer & Kreis 1978
Surirella biseriata var. bifrons f. amphioxys (W. Smith) Hustedt	Whitford & Schumacher 1973
Surirella biseriata var. bifrons f. punctata Meister	Stoermer et al. 1999
Surirella biseriata var. constricta Grunow	Whitford & Schumacher 1973
Surirella biseriata var. diminuta A. Cleve	Stoermer & Kreis 1978
Surirella biseriata var. orientalis Skvortzow	Stoermer et al. 1999
Surirella biseriata var. subacuminata Grunow	Clark & Rushforth 1977
Surirella bohemica Maly	Clark & Rushforth 1977
Surirella brebissonii Krammer & Lange-Bertalot	Stoermer et al. 1999
Surirella brebissonii var. kuetzingii Krammer & Lange-Bertalot	Potapova & Charles 2003
Surirella brightwellii W. Smith	Camburn 1982
Surirella capronii Kitton	Boyer 1927b
Surirella cardinalis Kitton	Stoermer & Kreis 1978
Surirella carolinensis	Ehrenberg 1856
Surirella carolinicola Camburn	Camburn 1982
Surirella circumsuta	Ehrenberg 1856
Surirella cocconeis	Ehrenberg 1856
Surirella constricta	Ehrenberg 1856
Surirella craticula Ehrenberg	Rushforth & Merkley 1988
Surirella crenulata Ehrenberg	H.L. Smith 1876–1888 (#517)
Surirella cruciata A. Schmidt	Tempère & Peragallo 1909
Surirella crumena Brébisson in Kützing	Boyer 1927b
Surirella cuspidata Hustedt	Camburn & Charles 2000
Surirella delicatissima Lewis	Stoermer & Kreis 1978
Surirella delicatissima f. tenuissima Manguin	Dixit & Smol 1995
Surirella didyma Kützing	Stoermer & Kreis 1978

Name	Publication
Surirella elegans Ehrenberg	Stoermer & Kreis 1978
Surirella elegans f. minor	Tempère & Peragallo 1908
Surirella elegans var. norwegica (Eulenstein) Brun	Clark & Rushforth 1977
Surirella elliptica Terry	Tempère & Peragallo 1908
Surirella engleri	Patrick & Roberts 1979
Surirella eximia	Ehrenberg 1856
Surirella fasciculata O. Müller	Stoermer et al. 1971
Surirella flexuosa	Ehrenberg 1856
Surirella geroltii Ehrenberg	H.L. Smith 1876–1888 (#517)
Surirella gracilis (W. Smith) Grunow	Stoermer & Kreis 1978
Surirella gracilis var. gigantea Tempère & Peragallo	Tempère & Peragallo 1909
Surirella guatemalensis Ehrenberg	Stoermer & Kreis 1978
Surirella helvetica Brun	Hansmann 1973
Surirella intermedia Lewis	Boyer 1927b
Surirella iowensis Lowe	Collins & Kalinsky 1977
Surirella kittonii A. Schmidt	Tempère & Peragallo 1908
Surirella kittonii var. asperula M. Peragallo in Tempère & Peragallo	Tempère & Peragallo 1908
Surirella lagerheimii Cleve	Stoermer & Kreis 1978
Surirella librile Ehrenberg	Stoermer & Kreis 1978
Surirella limosa J.W. Bailey	H.L. Smith 1876–1888 (#523)
Surirella linea	Ehrenberg 1856
Surirella linearis W. Smith	Stoermer & Kreis 1978
Surirella linearis var. constricta (Ehrenberg) Grunow	Stoermer & Kreis 1978
Surirella linearis var. helvetica (Brun) Meister	Stoermer & Kreis 1978
Surirella litoralis Hustedt	Kalinsky 1983
Surirella macra A. Schmidt	Cleve & Möller 1879
Surirella marylandica	Ehrenberg 1856
Surirella minuta Brébisson	Stoermer & Kreis 1978
Surirella molleriana Grunow	Stoermer & Kreis 1978
Surirella myodon Ehrenberg	Ehrenberg 1856
Surirella nervosa A. Schmidt	Aubert 1895
Surirella nevadensis Hanna & Grant	Kociolek & Herbst 1992
Surirella norvegica Eulenstein	Stoermer & Kreis 1978
Surirella oblonga Ehrenberg	Boyer 1927b
Surirella oophaena	Ehrenberg 1856
Surirella oregonica Ehrenberg	Stoermer & Kreis 1978
Surirella oregonica f. minor Tempère & Peragallo	Tempère & Peragallo 1909
Surirella ovalis Brébisson	Stoermer & Kreis 1978
Surirella ovalis var. angusta (Kützing) Van Heurck	Tilden 1894–1909 (#248)
Surirella ovalis var. baltica (Schumann) Cleve	Benson & Rushforth 1975
Surirella ovalis var. brightwellii (W. Smith) A. Cleve	Grimes & Rushforth 1982
Surirella ovalis var. minuta Van Heurck	Stoermer & Kreis 1978
Surirella ovata Kützing	Stoermer & Kreis 1978
Surirella ovata var. africana Cholnoky	Camburn 1982
Surirella ovata var. crumena (W. Smith) Hustedt	Stoermer & Kreis 1978
Surirella ovata var. pinnata (W. Smith) Rabenhorst	Stoermer & Kreis 1978
Surirella ovata var. salina (W. Smith) Rabenhorst	Stoermer & Kreis 1978
Surirella ovata var. subsalina	Patrick 1968
Surirella ovata var. utahensis Grunow	Rushforth & Merkley 1988
Surirella palmeri Boyer	Boyer 1927b
Surirella panduriformis W. Smith	Stoermer & Kreis 1978
Surirella parma Sovereign	Sovereign 1963
Surirella patella Ehrenberg	Whitford & Schumacher 1973
Surirella patella var. neupaueri (Pantocsek) Cleve-Euler	Whitford & Schumacher 1973
Surirella peisonis Pantocsek	Stoermer et al. 1999
Surirella pinnata W. Smith	Boyer 1927b
Surirella pinnata var. panduriformis (W. Smith) Hustedt	Stoermer et al. 1999

Name	Publication
Surirella plicata	Ehrenberg 1856
Surirella pseudovalis Hustedt	Grimes & Rushforth 1982
Surirella pygmaea	Ehrenberg 1856
Surirella rattrayi A. Schmidt	Aubert 1895
Surirella regina Janisch in A. Schmidt	Boyer 1927b
Surirella regula Ehrenberg	Ehrenberg 1856
Surirella robusta Ehrenberg	Stoermer & Kreis 1978
Surirella robusta var. armata Hustedt	Stoermer et al. 1999
Surirella robusta var. erosa	Tempère & Peragallo 1908
Surirella robusta var. splendida (Ehrenberg) Van Heurck	Stoermer & Kreis 1978
Surirella robusta var. splendida f. hustedtiana (Mayer) Hustedt	Bateman & Rushforth 1984
Surirella robusta var. splendida f. punctata Hustedt	Camburn 1982
Surirella robustior MacKay	Stoermer & Kreis 1978
Surirella rudis Hustedt	Czarnecki et al. 1981
Surirella saxonica Auerswald	Stoermer & Kreis 1978
Surirella sigmoidea Ehrenberg	Stoermer & Kreis 1978
Surirella spiralis Kützing	Stoermer & Kreis 1978
Surirella splendida Ehrenberg	Stoermer & Kreis 1978
Surirella splendida var. nervosa A. Schmidt	Tempère & Peragallo 1908
Surirella splendida f. punctata Hustedt	Sovereign 1958
Surirella stalagma Hohn & Hellerman	Camburn 1982
Surirella stoermerii Lowe	Lowe 1972–1973
Surirella striata Leud.-Fortm.	Stoermer & Kreis 1978
Surirella striatula Turpin	Stoermer & Kreis 1978
Surirella subsalsa W. Smith	Collins & Kalinsky 1977
Surirella suecica Grunow	Hohn & Hellerman 1963
Surirella suevica Zeller	Stoermer & Kreis 1978
Surirella tenera Gregory	Stoermer & Kreis 1978
Surirella tenera var. nervosa A. Schmidt	Stoermer & Kreis 1978
Surirella tenera var. palmeri (Boyer) Hustedt	Patrick 1945
Surirella tenera var. robusta	Tempère & Peragallo 1908
Surirella tenera var. splendidula A. Schmidt	Tempère & Peragallo 1908
Surirella tenuis Mayer	Stoermer et al. 1999
Surirella tenuissima Hustedt	Stoermer & Kreis 1978
Surirella terryi Ward	Boyer 1927b
Surirella testudinella	Ehrenberg 1856
Surirella testudo Ehrenberg	Ehrenberg 1856
Surirella triumphans A. Schmidt	Boyer 1927b
Surirella turgida W. Smith	Stoermer & Kreis 1978
Surirella undata Ehrenberg	Ehrenberg 1856
Surirella undulata Ehrenberg	Stoermer & Kreis 1978
Surirella utahensis (Grunow) Hanna & Grant	Rushforth & Merkley 1988
Surirella valida Ehrenberg	Tempère & Peragallo 1908
Surirella valida var. erosa	Tempère & Peragallo 1908
Surirella valida var. triumphanus	Tempère & Peragallo 1908
Surirella verrucosa Pantocsek	Hayak & Hulbary 1956
Surirella virginica	Ehrenberg 1856
Synedra actinastroides Lemmermann	Stoermer & Kreis 1978
Synedra acus Kützing	Stoermer & Kreis 1978
Synedra acus var. angustissima Grunow	Stoermer & Kreis 1978
Synedra acus var. delicatissima (W. Smith) Van Heurck	Patrick 1945
Synedra acus var. radians (Kützing) Hustedt	Stoermer & Kreis 1978
Synedra acuta Ehrenberg	Patrick & Reimer 1966
Synedra acutissimus	Patrick & Reimer 1966
Synedra aequalis Kützing	Boyer 1927a
Synedra affinis Kützing	Stoermer & Kreis 1978

Name	Publication
Synedra affinis var. acuminata Grunow	Rushforth & Merkley 1988
Synedra affinis var. fasciculata (Kützing) Grunow	Patrick & Reimer 1966
Synedra affinis var. gracilis Grunow	Collins & Kalinsky 1977
Synedra affinis var. lancettula Grunow	Rushforth & Merkley 1988
Synedra amphicephala Kützing	Stoermer & Kreis 1978
Synedra amphicephala var. asiatica Skvortzow	Stoermer et al. 1999
Synedra amphicephala var. austriaca (Grunow) Hustedt	Stoermer & Kreis 1978
Synedra amphicephala var. intermedia A. Cleve	Stoermer et al. 1999
Synedra amphioxys	Ehrenberg 1856
Synedra amphirhynchus Rabenhorst	Boyer 1927a
Synedra berolinensis Lemmermann	Drum 1981
Synedra biceps Kützing	Camburn 1982
Synedra bicurvata Biene in Rabenhorst	Boyer 1927a
Synedra capensis Grunow	Collins & Kalinsky 1977
Synedra capitata Ehrenberg	Stoermer & Kreis 1978
Synedra chaseii Thomas	Stoermer & Kreis 1978
Synedra crotonensis Grunow	Stoermer & Kreis 1978
Synedra crotonensis Edwards	Cleve & Möller 1878
Synedra crotonensis var. prolongata Grunow	Stoermer & Kreis 1978
Synedra cyclopum Brutschy	Stoermer & Kreis 1978
Synedra cyclopum var. gibbosa Naegeli	Prescott & Dillard 1979
Synedra cyclopum var. robustum Schulz	Patrick & Reimer 1966
Synedra danica Kützing	Stoermer & Kreis 1978
Synedra debilis	H.L. Smith 1876–1888 (#690)
Synedra delicatissima W. Smith	Stoermer & Kreis 1978
Synedra delicatissima var. angustissima Grunow	Stoermer & Kreis 1978
Synedra delicatissima f. longissima	Cleve & Möller 128
Synedra delicatissima var. mesoleia	Tempère & Peragallo 1909
Synedra demerarae Grunow	Stoermer & Kreis 1978
Synedra dicephala	Patrick & Reimer 1966
Synedra dorsiventralis Müller	Patrick & Reimer 1966
Synedra entomon	Ehrenberg 1856
Synedra famelica Kützing	Stoermer & Kreis 1978
Synedra fasciculata (Agardh) Kützing	Stoermer & Kreis 1978
Synedra fasciculata var. truncata (Greville) Patrick	Stoermer & Kreis 1978
Synedra filiformis Grunow	Stoermer & Kreis 1978
Synedra filiformis var. exilis A. Cleve	Stoermer & Kreis 1978
Synedra flexuosa	Ehrenberg 1856
Synedra gaillonii (Bory) Ehrenberrg	Stoermer & Kreis 1978
Synedra goulardi Brébisson	Stoermer & Kreis 1978
Synedra goulardi var. fluviatilis (Lemmermann) Frenguelli	Stoermer et al. 1999
Synedra homostriata Hohn	Patrick & Reimer 1966
Synedra hyalina Tempère & Peragallo	Patrick & Reimer 1966
Synedra hyperborea Grunow	Stoermer & Kreis 1978
Synedra hyperborea var. rostellata Grunow	Stoermer & Kreis 1978
Synedra incisa Boyer	Stoermer & Kreis 1978
Synedra laevigata Grunow	Stoermer & Kreis 1978
Synedra lanceolata Kützing	Stoermer & Kreis 1978
Synedra longiceps Ehrenberg	Stoermer & Kreis 1978
Synedra longissima W. Smith	Stoermer & Kreis 1978
Synedra lunaris Ehrenberg	Stoermer & Kreis 1978
Synedra mazamaensis Sovereign	Stoermer et al. 1999
Synedra minuscula Grunow	Stoermer & Kreis 1978
Synedra montana Krasske	Stoermer & Kreis 1978
Synedra nana Meister	Camburn 1982
Synedra netronoides Hohn & Hellerman	Collins & Kalinsky 1977
Synedra notha Hohn & Hellerman	Patrick & Reimer 1966

Name	Publication
Synedra obtusa W. Smith	Boyer 1927a
Synedra ostenfeldii (Krieger) A. Cleve	Stoermer et al. 1999
Synedra oxyrhynchus Kützing	Boyer 1927a
Synedra oxyrhynchus var. undulata Grunow	Patrick & Reimer 1966
Synedra parallelogram	Patrick & Reimer 1966
Synedra parasitica (W. Smith) Hustedt	Camburn 1982
Synedra parasitica var. subconstricta (Grunow) Hustedt	Camburn 1982
Synedra parvlua Kützing	Boyer 1927a
Synedra pulchella Ralfs ex Kützing	Camburn 1982
Synedra pulchella var. abnormis Macchiati	Boyer 1927a
Synedra pulchella var. flexella Boyer	Boyer 1927a
Synedra pulchella var. lacerata Hustedt	Camburn 1982
Synedra pulchella var. lanceolata O'Meara	Whitford & Schumacher 1973
Synedra pulchella f. major Grunow in Van Heurck	Patrick & Reimer 1966
Synedra recava Hohn	Patrick & Reimer 1966
Synedra radians Kützing	Camburn 1982
Synedra rumpens Kützing	Camburn 1982
Synedra rumpens var. familiaris (Kützing) Hustedt	Camburn 1982
Synedra rumpens var. fragilariodes Grunow	Camburn 1982
Synedra rumpens var. meneghiniana Grunow	Camburn 1982
Synedra rumpens var. scotica Grunow	Camburn 1982
Synedra scalaris Ehrenberg	Patrick & Reimer 1966
Synedra simalongis W. Smith	Stoermer et al. 1999
Synedra socia Wallace	Collins & Kalinsky 1977
Synedra spathulifera Grunow	Boyer 1927a
Synedra spectabilis	Ehrenberg 1856
Synedra splendens Kützing	Boyer 1927a
Synedra stauroneis	Ehrenberg 1856
Synedra stela Hohn & Hellerman	Stoermer et al. 1999
Synedra subaequalis (Grunow) Van Heurck	Smith 1950
Synedra subrhombica Nygaard	Camburn & Charles 2000
Synedra subtilis Kützing	H.L. Smith 1876–1888 (#579)
Synedra tabulata (Agardh) Kützing	Camburn 1982
Synedra tabulata var. accuminata Grunow	Drum 1981
Synedra tabulata var. obtusa (Arnott) Cleve	Kaczmarska & Rushforth 1983
Synedra tenera W. Smith	Collins & Kalinsky 1977
Synedra tenera f. elongata	Cleve & Möller 1878
Synedra tenuissima Kützing	Stoermer et al. 1999
Synedra ulna (Nitzsch) Ehrenberg	Camburn 1982
Synedra ulna var. aequalis (Kützing) Hustedt	Camburn 1982
Synedra ulna var. amphirhynchus (Ehrenberg) Grunow	Camburn 1982
Synedra ulna var. biceps (Kützing) Kirchner	Stoermer et al. 1999
Synedra ulna var. capitata Ehrenberg	Patrick & Reimer 1966
Synedra ulna var. chaseana Thomas	Stoermer et al. 1999
Synedra ulna var. claviceps Venkataraman	Stoermer et al. 1999
Synedra ulna var. constricta Venkataraman	Hohn 1961
Synedra ulna var. contracta Østrup	Camburn 1982
Synedra ulna var. danica (Kützing) Van Heurck	Camburn 1982
Synedra ulna var. delicatissima	Patrick & Reimer 1966
Synedra ulna var. impressa Hustedt	Stoermer et al. 1999
Synedra ulna var. impressa f. contracta	Patrick 1968
Synedra ulna var. lanceolata Grunow	Tempère & Peragallo 1908
Synedra ulna var. longissima (W. Smith) Brun	Collins & Kalinsky 1977
Synedra ulna var. obtusa Van Heurck	Collins & Kalinsky 1977
Synedra ulna var. oxyrhynchus (Kützing) Van Heurck	Camburn 1982
Synedra ulna var. oxyrhynchus f. mediocontracta (Forti) Hustedt	Whitford & Schumacher 1973
Synedra ulna var. radians	Patrick & Reimer 1966

Name	Publication
Synedra ulna var. ramesi (Héribaud) Hustedt	Camburn 1982
Synedra ulna var. spathulifera Grunow	Collins & Kalinsky 1977
Synedra ulna var. splendens Kützing	Collins & Kalinsky 1977
Synedra ulna var. subaequalis (Grunow) Van Heurck	Rushforth & Squires 1985
Synedra ulna var. vitraea Van Heurck	Tempère & Peragallo 1908
Synedra utermohlii Hustedt	Stoermer et al. 1999
Synedra valens Ehrenberg	Patrick & Reimer 1966
Synedra vaucheriae Kützing	Boyer 1927a
Synedra vaucheriae var. capitellata (Grunow) Cleve	Stoermer et al. 1999
Synedra vaucheriae var. truncata (Greville) Grunow	Stoermer et al. 1999
Synedra vitrea Kützing	Boyer 1927a
Tabellaria binalis (Ehrenberg?) Grunow	Boyer 1927a
Tabellaria fenestrata (Lyngbye) Kützing	Camburn 1982
Tabellaria fenestrata var. asterionelloides Grunow	Stoermer et al. 1999
Tabellaria fenestrata var. geniculata A. Cleve	Stoermer et al. 1999
Tabellaria fenestrata var. gracilis Meister	Patrick & Reimer 1966
Tabellaria fenestrata var. intermedia Grunow	Stoermer et al. 1999
Tabellaria flocculosa (Roth) Kützing	Camburn 1982
Tabellaria flocculosa var. linearis Koppen	Stoermer et al. 1999
Tabellaria nodosa	Ehrenberg 1856
Tabellaria quadriseptata Knudson	Stoermer et al. 1999
Tabellaria silicula	Ehrenberg 1856
Tabellaria teilingii	Patrick & Reimer 1966
Tabellaria trinodis Ehrenberg	Stoermer et al. 1999
Tabellaria venter Ehrenberg	Patrick & Reimer 1966
Tabellaria ventricosa Kützing	Aubert Le Diatomiste #20
Tabellaria vulgaris Ehrenberg	Patrick & Reimer 1966
Tabularia fasciculata (C. Agardh) Williams & Round	Stoermer et al. 1999
Terpsinoe americana (Bailey) Ralfs	Boyer 1927a
Terpsinoe intermedia Grunow	Kaczmarska & Rushforth 1983
Terpsinoe musica Ehrenberg	Stoermer & Kreis 1978
Tetracyclus elliptica (Ehrenberg) Grunow	Patrick & Reimer 1966
Tetracyclus emarginatus (Ehrenberg) W. Smith	Patrick & Reimer 1966
Tetracyclus lacustris Ralfs	Patrick & Reimer 1966
Tetracyclus rupestris (A. Braun) Grunow	Stoermer & Kreis 1978
Tetracyclus stella Ehrenberg	Tempère & Peragallo 1909
Tetracyclus rhombus var. maxima	Tempère & Peragallo 1909
Tetragramma americana	Ehrenberg 1856
Thalassiocyclus lucens Håkansson & Mahood	Stoermer et al. 1999
Thalassiosira bramaputrae (Ehrenberg) Håkansson & Locker	Stoermer et al. 1999
Thalassiosira fluviatilis Hustedt	Stoermer & Kreis 1978
Thalassiosira guillardii Hasle	Stoermer et al. 1999
Thalassiosira incerta Makarova	Stoermer et al. 1999
Thalassiosira lacustris (Grunow) Hasle	Stoermer et al. 1999
Thalassiosira levanderi Van Goor	Stoermer & Kreis 1978
Thalassiosira pseudonana Hasle & Heim	Stoermer & Kreis 1978
Thalassiosira simplex Hustedt	Stoermer et al. 1999
Thalassiosira visurgis Hustedt	Stoermer & Kreis 1978
Thalassiosira weissflogii (Grunow) Fryxell & Hasle	Camburn 1982

Name	Publication
Triceratium jensenianum Grunow	Collins & Kalinsky 1977
Triceratium solenoceros Ehrenberg	Collins & Kalinsky 1977
Triceratium venosum Brighton	Collins & Kalinsky 1977
Tropidoneis lepidoptera (Gregory) Cleve	Stoermer & Kreis 1978
Tropidoneis lepidoptera var. proboscidea Cleve	Stoermer & Kreis 1978
Tropidoneis vitrea (W. Smith) Cleve	Rushforth & Merkley 1988
Tropidoneis vitrea var. scaligera (Grunow) Cleve	Rushforth & Merkley 1988
Tryblionella acuta (Cleve) D.G. Mann	Stoermer et al. 1999
Tryblionella angustata W. Smith	Stoermer et al. 1999
Tryblionella angustata var. acuta (Grunow) Bukhtiyarova	Stoermer et al. 1999
Tryblionella apiculata Gregory	Stoermer et al. 1999
Tryblionella debilis (Arnott) Grunow in Cleve & Grunow	Stoermer et al. 1999
Tryblionella gracilis W. Smith	Stoermer et al. 1999
Tryblionella hungarica (Grunow) D.G. Mann	Stoermer et al. 1999
Tryblionella levidensis W. Smith	Stoermer & Kreis 1978
Tryblionella plana var. fennica (Hustedt) Simola	Siver et al. 2005
Tryblionella scutellum (Bailey) W. Smith	Stoermer & Kreis 1978
Tryblionella victoriae Grunow	Stoermer et al. 1999
Ulnaria ulna (Nitzsch) Compère	Siver et al. 2005
Urosolenia eriensis (H.L. Smith) Round & Crawford	Stoermer et al. 1999
Urosloenia gracilis (H.L. Smith) Andresen et al.	Andresen et al. 2000
Urosolenia longiseta (Zach.) Edlund & Stoermer	Stoermer et al. 1999
Vanheurckia rhomboides (Ehrenberg) Brébisson	Patrick 1945
Vanheurckia rhomboides var. amphipleuroides (Brébisson) Van Heurck	Patrick 1945
Vanheurckia rhomboides var. crassinervia (Brébisson) Van Heurck	Patrick 1945
Vanheurckia rhomboides var. crassinervia f. capitata Patrick	Patrick 1945
Vanheurckia viridula Brébisson	Tempère & Peragallo 1908
Vanheurckia vulgaris (Thwaites) Van Heurck	Patrick 1945

Section III: Bibliography

ABBOTT, M.R., POWELL, T.M. AND RICHERSON, P.J. 1982. The relationship of environmental variability to the spatial patterns of phytoplankton biomass in Lake Tahoe. *Journal of Plankton Research* 4:927–941.

AHLSTROM, E.H. 1936. The deep-water plankton of Lake Michigan, exclusive of the Crustacea. *Transactions of the American Microscopical Society* 55:286–299.

ALLEN, W.E. 1920. A quantitative and statistical study of the plankton of the San Joaquin River and its tributaries in and near Stockton, California, in 1913. *University of California Publications in Zoology* 22:1–292.

ALOI, J.E., LEOB, S.L. AND GOLDMAN, C.R. 1988. Temporal and spatial variability of the eulittoral epilithic periphyton, Lake Tahoe, California-Nevada. *Journal of Freshwater Ecology* 4:401–410.

ANDERSEN, E.N. AND WALKER, E.R. 1920. An ecological study of the algae of some sandhill lakes. *Transactions of the American Microscopical Society* 39:51–85.

ANDRESEN, N.A. 1970. Algae in Park Lake, Clinton County, Michigan. *Michigan Botanist* 9:95–107.

ANDRESEN, N.A. AND STOERMER, E.F. 1978. The diatoms of Douglas Lake — A preliminary list. *Michigan Botanist* 17:49–54.

Andresen, N.A., Stoermer, E.F. and Kreis, R.G. Jr. 2000. New nomenclatural combinations referring to diatom taxa which occur in the Laurentian Great Lakes of North America. *Diatom Research* 15:411–416.

Andresen, N.A. and Tuchman, M.L. 1991. Anomalous diatom populations in Lakes Michigan and Huron in 1983. *Journal of Great Lakes Research* 17:144–149.

Anderson, D.C. and Rushforth, S.R. 1976. The cryptogam flora of desert soil crusts in southern Utah, USA. *Nova Hedwigia* 28:691–729.

Anderson, F.W. and Kelsey, F.D. 1891. Common and conspicuous algae of Montana. *Bulletin of the Torrey Botanical Club* 18:137–146.

Ashley, J. and Rushforth, S.R. 1984. Growth of soil algae on top soil and processed oil shale from Uintah Basin, Utah, USA. *Reclamation and Revegetation Research* 3:49–63.

Ashley, J., Rushforth, S.R. and Johansen, J.R. 1985. Soil algae of cryptogamic crusts from the Uintah Basin, Utah, USA. *Great Basin Naturalist* 45:432–442.

Aubert, A.-B. 1895. Diatomées du Mont Ktaadu (Katahdin) (Etat du Maine). *Le Diatomiste* 2:211–212.

Austin, A. and Deniseger, J. 1985. Periphyton community changes along a heavy metals gradient in a long narrow lake. *Environmental and Experimental Botany* 25:41–52.

Ayers, J.C. 1970. *Lake Michigan Environmental Survey. Final Report.* University of Michigan, Great Lakes Research Division, Special Report No. 49. Ann Arbor, Michigan, USA. 67 pp.

Ayers, J.C. 1975. *Benton Harbor Power Plant Limnological Studies. Part XXI. Bacteria and Phytoplankton of the Seasonal Surveys of 1972 and 1973.* University of Michigan, Great Lakes Research Division, Special Report No. 44. Ann Arbor, Michigan, USA. vi + 153 pp.

Ayers, J.C. 1978. *Benton Harbor Power Plant Limnological Studies. Part XXV. Phytoplankton of the Seasonal Surveys of 1976, of September 1970, and Pre- vs. Post-operational Comparisons at Cook Nuclear Plant.* University of Michigan, Great Lakes Research Division Special Report 44. Ann Arbor, Michigan, USA. 258 pp.

Ayers, J.C., Southwick N.V., and Robinson, D.G. 1977. *Benton Harbor Power Plant Limnological Studies. Part XXIII. Phytoplankton of the Seasonal Surveys of 1974 and 1975 and Initial Pre- vs. Post-operational Comparisons at Cook Nuclear Plant.* University of Michigan, Great Lakes Research Division, Special Report 44. Ann Arbor, Michigan, USA. vii + 279 pp.

Ayers, J.C. and Feldt, L.E. 1982. *Benton Harbor Power Plant Limnological Studies. Part XXIX. Phytoplankton of the Seasonal Surveys of 1978 and 1979 and Further Pre- vs. Post-operational Comparisons at Cook Nuclear Plant.* University of Michigan, Great Lakes Research Division, Special Report 44. Ann Arbor, Michigan, USA. 70 pp.

Bahls, L.L. 1973. Diatom community response to primary wastewater effluent. *Journal of the Water Pollution Control Federation* 45:134–144.

Bahls L.L. 1981. Diatoms of Lewis and Clark Caverns. *Proceedings of the Montana Academy of Sciences* 40:11–18.

Bahls L.L. 1982. Eight new diatom genus records for Montana. *Proceedings of the Montana Academy of Sciences* 41:79–86.

Bahls L.L. 1983. A new diatom from Southeastern Montana. *Proceedings of the Montana Academy of Sciences* 42:1–6.

Bahls, L.L. 1993. *Periphyton Bioassessment Methods for Montana Streams.* Water Quality Bureau, Department of Health and Environmental Sciences, Helena, Montana, USA. 22 pp.

Bahls L.L, Weber E.E. and Jarvie J.O. 1984. *Ecology and Distribution of Major Diatom Ecotypes in the Southern Fort Union Coal Region of Montana.* U.S. Geological Survey Professional Paper 1289. 151 pp.

Bailey, J.W. 1841. A sketch of the infusoria in the family Bacillaria, with some account of the most interesting species which have been found in a recent or fossil state in the United State. *American Journal of Science* 41:284–305.

Bailey, J.W. 1842. A sketch of the infusoria in the family Bacillaria, with some account of the most interesting species which have been found in a recent or fossil state in the United State. Part 2. *American Journal of Science* 42:88–205.

Bailey, J.W. 1842. A sketch of the infusoria in the family Bacillaria, with some account of the most interesting species which have been found in a recent or fossil state in the United State. Part 3. *American Journal*

of Science 43:321–332.

BAILEY, J.W. 1851. Microscopical observations made in south Carolina, Georgia and Florida. *Smithsonian Contributions to Knowledge* 2:1–48.

BAILEY, J.W. 1854. Notes on new species and localities of microscopical organisms. *Smithsonian Contributions to Knowledge* 7:1–16.

BAKER, D.B., JACKSON, W.B. AND PRATER, B.L., EDS. 1975. *Proceedings of Sandusky River Basin Symposium, May 2–3, 1975, Tiffin, Ohio*. International Reference Group on Great Lakes Pollution from Land Use Activities, International Joint Commission, 1976-653-346. 475 pp.

BALL, R.C. AND T.G. BAHR. 1975. Intensive survey: Red Cedar River, Michigan. Pages 431–460 *in* B.A. Whitton, ed., *River Ecology*. University of California Press, Berkeley, California, USA.

BATEMAN, L. AND RUSWHFORTH, S.R. 1984. Diatom floras of selected Uinta Mountains lakes Utah, U.S.A. *Bibliotheca Diatomologica* 4:1–99.

BAYLIS, J.R. 1957. Microorganisms that have caused trouble in the Chicago water system. *Pure Water* 9:47–74.

BEETON, A.M. 1965. Eutrophication of the St. Lawrence Great Lakes. *Limnololgy and Oceanography* 10:240–254.

BEETON, A.M. 1969. Changes in the environment and biota of the Great Lakes. Pages 150–187 in *Eutrophication: Causes, Consequences, Correctives*. National Academy of Sciences, Washington, DC, USA.

BEETON, A.M. AND SAYLOR, J.H. 1995. Limnology of Lake Huron. Pages 1–37 *in* Munawar, M., T.Edsall and J. Leach, eds., *The Lake Huron Ecocystem: Ecology, Fisheries and Management*. Ecovision World Monograph Series, SPB Academic Publishing, Amsterdam, The Netherlands.

BEETON, A. M. AND W.T. EDMONDSON. 1972. The eutrophication problem. *Journal of Fisheries Research Board of Canada* 29:673–682.

BELL, D.M. 1977. Effects of zinc mine groundwater effluent on a stream diatom community. *Proceedings of the Pennsylvania Academy of Science* 51:51–53.

BENOIT, R.J., CAIRNS, JR., J.J. AND REIMER, C.W. 1967. A limnological reconnaissance of an impoundment receiving heavy metals, with emphasis on diatoms and fish. Pages 69–99 in *Reservoir Fishery Resources Symposium*. University of Georgia, Athens, Georgia, USA.

BENSON, C.E. AND RUSHFORTH, S.R. 1975. The algal flora of Huntington Canyon Utah, U.S.A. *Bibliotheca Phycologia* 18:1–177.

BERGEY, E.A., BOETTIGER, C.A. AND RESH, V.H. 1995. Effects of water velocity on the architecture and epiphytes of *Cladophora glomerata* (Chlorophyta). *Journal of Phycology* 31:264–271.

BERNER, L.M. 1951. Limnology of the Lower Missouri River. *Ecology* 32:1–12.

BESSEY, C.E. 1884. Preliminary lists of the Protophytes, zygophytes, Oophytes, Carpophytes and Bryophytes of the Ames flora. *Bulletin of the Botany Department, Iowa Agricultural College* 1884:133–150.

BIERMAN, V.J., JR., DOLAN, D.M., STOERMER, E.F., GANNON, J.E. AND SMITH, V.E. 1980. *The Development and Calibration of a Spatially Simplified Multi-class Phytoplankton Model for Saginaw Bay, Lake Huron*. Great Lakes Planning Study Contribution No. 33. Great Lakes Basin Commission, Ann Arbor, Michigan, USA.

BLAKE, J. 1871. On some diatoms from a hot spring in Pueblo Valley, Humboldt County, Nevada. *Proceedings of the California Academy of Sciences*, ser. 1, 4:183.

BLINN, D.W. 1993. Diatom community structure along physico-chemical gradients in saline lakes. *Ecology* 74:1246–1263.

BLINN, D.W. AND COLE, G.A. 1991. Algal and invertebrate biota in the Colorado River: comparison of pre- and post-dam conditions. Pages 85–104 in *Colorado River Ecology and Dam Management*. National Academy of Sciences Press, Washington, DC, USA.

BLINN, D.W., FREDERICKSEN, W.A. AND KORTE, V. 1980. Colonization rates and community structure of diatoms on three different rock substrata in a lotic system. *British Phycological Journal* 15:303–310.

BLINN D.W., HURLEY, M. AND BROKAW, L. 1981. The effect of saline seeps and restricted light upon the seasonal dynamics of phytoplankton communities within a southwestern (USA) desert canyon stream. *Archiv für Hydrobiologie* 92:287–305.

Blinn, D.W., Truitt, R. and Pickart, A. 1989. Response of epiphytic diatom communities from the tailwaters of Glen Canyon Dam, Arizona, to elevated water temperature. *Regulated Rivers* 4:91–95.

Blum, J.L. 1954. Two winter diatom communities of Michigan streams. *Papers of the Michigan Academy of Science, Arts and Letters* 39:3–7.

Blum, J.L. 1956. The ecology of river algae. *Botanical Review* 22:291–341.

Blum, J.L. 1957. An ecological study of the algae of the Saline River, Michigan. *Hydrobiologia* 9:361–408.

Blum, J.L. 1960. Algal populations in flowing waters. Pages 11–21 *in* C. Tryon and R. Hartman, eds., *The Ecology of Algae*. Pymatuning Laboratory of Field Biology, Special Publications, 2. University of Pittsburgh, Pittsburgh, Pennsylvania, USA.

Blum, J.L. 1963. The influences of water currents on the life functions of algae. *Annals of the New York Academy of Science* 108:153–158.

Boucher, P., Blinn, D.W. and Johnson, D.B. 1984. Phytoplankton ecology in an unusually stable environment (Montezuma Well, Arizona, U.S.A.). *Hydrobiologia* 119:149–160.

Bourne, C.E.M., and Sicko-Goad, L. 1984. Ultrastructure of *Melosira* resting cell rejuvenation. *Annual Proceedings of the Electron Microscopy Society of America* 42:734–735.

Boyer, C.S. 1901. The biddulphoid forms of North American Diatomaceae. *Proceedings of the Academy of Natural Sciences of Philadelphia* 52:685–748.

Boyer, C.S. 1914. A new diatom. *Proceedings of the Academy of Natural Sciences of Philadelphia* 66:219–221.

Boyer, C.S. 1916. *Diatomaceae of Philadelphia and Vicinity*. Lippincott, Philadelphia, Pennsylvania, USA. 143 pp.

Boyer, C.S. 1927a. Synopsis of the North American Diatomaceae. *Proceedings of the Academy of Natural Sciences of Philadelphia* Supplement 78:1–228.

Boyer, C.S. 1927b. Synopsis of the North American Diatomaceae. *Proceeding of the Academy of Natural Sciences of Philadelphia* Supplement 79:229–583.

Brant, L.A. 2003. A new species of *Meridion* (Bacillariophyceae) from western North Carolina. *Southeastern Naturalist* 2:409–418.

Brewer, W.H. 1866. Observations on the presence of living species in hot and saline water in California. *American Journal of Science and Arts* II 41:391–393.

Brewer, W.H. 1866. Notes on the organisms of the Geysers of California. *American Journal of Science and Arts* II 42:429.

Briggs, S.A. 1872. The Diatomaceae of Lake Michigan. *The Lens* 1:41–44.

Briggs, S.A. 1872. [description of *Rhizosolenia eriensis*]. *Grevillea* 1:14.

Brinley, F.J. and Katzin, L.J. 1942. Distribution of stream plankton in the Ohio River system. *American Midland Naturalist* 27:177–190.

Britton, M.E. 1944. *A Catalog of Illinois Algae*. Northwestern University Studies in the Biological Sciences and Medicine. Number 2. Evanston, Illinois, USA.

Britton, N.L. 1884. On the composition and distribution of the flora of New Jersey. *Botanical Gazette* 9:156.

Brooks, A.S. and Torke, B.G. 1977. Vertical and seasonal distribution of chlorophyll α in Lake Michigan. *Journal of the Fisheries Research Board of Canada* 34:2280–2287.

Brooks, A.S., Warren, G.J., Boraas, M.E., Scale, D.B. and Edgington, D.N. 1984. Long-term phytoplankton changes in Lake Michigan: Cultural eutrophication or biotic shifts. *Verhandlungen der Internationale Verein Limnologie* 22:460–469.

Brown, C.L. and Manny, B.A. 1983. Nearshore phytoplankton of Hammond Bay, Lake Huron. *Journal of Great Lakes Research* 9:523–529.

Brown, H.D. 1976. A comparison of the attached algalcommunities of a natural and artificial substrate. *Journal of Phycology* 12:301–306.

Brown, S.D. and Austin, A.P. 1973. Diatom succession and interaction in littoral periphyton and plankton. *Hydrobiologia* 43:333–356.

Brugam, R.B. and Patterson, C. 1983. The A/C (Araphidineae/Centrales) ration in high and low alkalinity lakes in eastern Minnesota. *Freshwater Biology* 13:47–55.

Bruno M.G and Lowe, R.L. 1980. Differences in the distribution of some bog diatoms: a cluster analysis.

American Midland Naturalist. 104(1):70–79.

Buchanan, R.E. 1908. Notes on the algae of Iowa. *Proceedings of the Iowa Academy of Science* 14:47–84.

Burkholder, J.M. and Wetzel, R.G. 1989. Microbial colonization on natural and artificial macrophytes in a phosphorus-limited hardwater lake. *Journal of Phycology* 25:55–65.

Burkholder, P.R. 1928. Microplankton studies of Lake Erie. *New York State Conservation Department, Annual Report*, Supplement 18:60–66.

Burkholder, P.R. 1929. Microplankton studies of Lake Erie. *Bulletin of the Buffalo Society of Natural Science* 14:73–93

Burns, N.M. 1985. *Erie: The Lake that Survived.* Rowman and Allanheld, Totowa, New Jersey, USA. 320 pp.

Burton, T.M., Oemke, M.P. and Molloy, J.M. 1994a. Effects of grazing by the trichopteran, *Glossoma nigrior*, on diatom community composition in the Ford River, Michigan. Pages 599–608 *in* J.P. Kociolek, *Proceedings of the 11th International Diatom Symposium, San Francisco, California, 12–17 August 1990.* Memoirs of the California Academy of Sciences, No. 17. San Francisco, California, USA.

Burton, T.M., Oemke, M.P. and Molloy, J.M. 1994b. Effects of stream order and alkalinity on the composition of diatom communities in two northern Michigan river systems. Pages 609–620 *in* J.P. Kociolek, *Proceedings of the 11th International Diatom Symposium, San Francisco, California, 12–17 August 1990.* Memoirs of the California Academy of Sciences, No. 17. San Francisco, California, USA.

Busch, D.E. 1974. Ultrastructure of the filamentous habit in the diatom *Navicula confervacea* (Kütz.) Grun. *Journal of Phycology* 10:241–243.

Cairns, J., Jr., Dickson, K.L., Pryfogle, P., Almedia, S.P., Case, S.K., Fournier, J.M. and Fuji, H. 1979. Determining the accuracy of coherent optical identification of diatoms. *Water Resources Bulletin* 15:1770-1775.

Cairns, J. Jr., Kaesler, R.L. and Patrick, R.M. 1970. Occurrence and distribution of diatoms and other algae in the upper Potomac River. *Notulae Naturae* 436:1–12.

Cairns, J. Jr; Plafkin, J.L., Kaesler, R.L. and Lowe, R.L. 1983. Early colonization patterns of diatoms and protozoa in fourteen freshwater lakes. *Journal of Protozoology* 30:47–51.

Camburn, K.E. 1982. Subaerial diatom communities in eastern Kentucky. *Transactions of the American Microscopical Society* 101:375–387.

Camburn, K.E. 1982. The diatoms (Bacillariophyceae) of Kentucky: A checklist of previously reported taxa. *Transactions of the Kentucky Academy of Science* 43:1–20.

Camburn, K.E. 1983. Subaerial algae from eastern Kentucky. *Castanea* 48:83–88.

Camburn, K.E. and Charles, D.F. 2000. *Diatoms of Low Alkalinity Lakes in the Northeastern United States.* Academy of Natural Sciences of Philadelphia, Special Publication 18. 152 pp.

Camburn, K.E. and Lowe, R.L. 1978. *Achnanthes subrostrata* var. *appalachiana* Camburn and Lowe var. nov., a new diatom from the southern Appalachian Mountains. *Castanea* 43:247–255.

Camburn, K.E., Lowe, R.L. and Stoneburner, D.L. 1978. The haptobenthic diatom flora of Long Branch Creek, South Carolina. *Nova Hedwigia* 30:149–279.

Camburn, K. E. and Kingston, J.C. 1986. The genus *Melosira* from soft-water lakes with special reference of northern Michigan, Wisconsin and Minnesota. Pages 17–34 *in* J.P. Smol, R.W. Battarbee, R.B. Davis and J. Meriliinen, eds., *Diatoms and Lake Acidity*. Junk, Dordrecht, The Netherlands.

Camburn, K.E., Kingston, J.C. and Charles, D.F., eds. 1984–1986. *PIRLA Diatom Iconograph.* PIRLA Unpublished Report Series, Report 3. Electric Power Research Institute. 53 plates, 1059 figs.

Carney, H.J. 1987. Field tests of interspecific resource-based competition among phytoplankton. *Proceedings of the National Academy of Sciences, USA*. 84:4148–4150.

Carney, H.J., Richerson, P.J., Goldman, C.R. and Richards, R.C. 1988. Seasonal phytoplankton demographic processes and experiments on interspecific competition. *Ecology* 69:664–678.

Carpenter, K.D. and Waite, I.R. 2000. Relations of habitat-specific algal assemblages to land use and water chemistry in the Willamette basin, Oregon. *Environmental Monitoring and Assessment* 64:247–257.

Carr, J.M. and Hergenrader, G.L. 1987. Occurrence of three *Nitzschia* (Bacillariophyceae) taxa within colonies of tube-forming diatoms. *Journal of Phycology* 23:62–70.

Carrick, H.J. and Lowe, R.L. 1988. Response of Lake Michigan benthic algae to *in situ* enrichment with Si, N and P. *Canadian Journal of Fisheries and Aquatic Sciences* 45:271–279.

Carrick, H.J., Lowe, R.L. and Rotenberry, J.T. 1988. Guilds of benthic algae along nutrient gradients: relationships to algal community diversity. *Journal North American Benthological Society* 7:117–128.

Carter, J.R. and Flower, R.J. 1988. A new species of *Eunotia, E. pirla* sp. nov., from Woolmer Pond, an acid pool in the southeast of England. *Diatom Research* 3:1–8.

Cartledge, J.L. 1933. Some interesting algae from western Pennsylvania. *Proceedings of the Pennsylvania Academy of Science* 7:79–81.

Carvalho, L.R., Cox, E.J., Fritz, S.C., Juggins, S., Sims, P.A., Gasse, F. and Battarbee, R.W. 1995. Standardizing the taxonomy of saline lake *Cyclotella* spp. *Diatom Research* 10:229–240.

Casterlin, M.E. and Reynolds, W.W. 1977. Seasonal algal succession and cultural eutrophication in a north temperate lake. *Hydrobiologia* 54:99–108.

Chandler, D.C. 1937. Fate of typical lake plankton in streams. *Ecological Monographs* 7:445–479.

Chandler, D.C. 1939. Plankton entering the Huron River from Portage and Base Line Lakes, Michigan. *Transactions of the American Microscopical Society* 58:24–41.

Chandler, D.C. 1940. Limnological studies of western Lake Erie; I; plankton and certain physical-chemical data of the Bass Islands region, from September, 1938, to November, 1939. *Ohio Journal of Science* 40:291–336.

Chandler, D.C. 1942. Limnological studies of western Lake Erie; II; light penetration and its relation to turbidity. *Ecology* 23 :41–52.

Chandler, D.C. 1942. Limnological studies of western Lake Erie; III; Phytoplankton and physical-chemical data from November, 1939, to November 1940. *Ohio Journal of Science* 42:24–44.

Chandler, D.C. 1944. Limnological studies of western Lake Erie; IV; relation of limnological and climatic factors to the phytoplankton of 1941. *Transactions of the American Microscopical Society* 63:203–236.

Chandler, D.C. 1963. Michigan. Pages 95–115 *in* D.G Frey, ed., *Limnology in North America*. The University of Wisconsin Press, Madison, Wisconsin, USA.

Chandler, D.C. 1967. *The St. Laurence Great Lakes*. Pages 280–296 *in* University of Michigan, Great Lakes Research Division Special Publications 1. Ann Arbor, Michigan, USA.

Chandler, D.C. and O.B. Weeks. 1945. Limnological studies of western Lake Erie. V. Relation of limnological and meteorological conditions to the production of phytoplankton in 1942. *Ecological Monographs* 15:435–456.

Chapman, F.B. 1934. The algae of the Urbana (Ohio) raised bog. *Ohio Journal of Science* 34:327–332.

Charles, D.F. 1985, Relationships between surface sediment diatom assemblages and lakewater characteristics in Adirondack lakes. *Ecology* 66:994–1011.

Charles, D.F. 1986. The Pirla Project (Paleoecological Investigation of Recent Lake Acidification): Preliminary results for the Adirondacks, New England, N. Great Lakes and N. Florida. *Water and Air Pollution* 30:355–365.

Charles, D.F. 1986. A new diatom species, *Fragilaria acidobiontica*, from acidic lakes in northeastern North America. Pages 35–44 *in* J.W. Smol, R.W. Battarbee, R.B. David and J. Meriluainen, eds., *Diatoms and Lake Acidity*. Junk, Dordrecht, The Netherlands.

Charles, D.F. 1990. Effects of acidic deposition on North American lakes: Paleolimnological evidence from diatoms and chrysophytes. *Philosophical Transactions of the Royal Society of London Series B, Biological Sciences* 327:403–412.

Charles, D.F. and Whitehead, D.R. 1986. The PIRLA project: Paleoecological investigations of recent lake acidification. *Hydrobiologia* 143:13–20.

Chase, H.H. 1904. Flora Michiganensis. Algae. Diatomaceae. *Fifth Annual Report of the Michigan Academy of Science, Arts, and Letters* 5:166–169.

Christensen, C.L. 1969. Notes on Iowa diatoms IX: Variation in the genus *Eunotia*. *Proceedings of the Iowa Academy of Science* 76:62–68.

Christensen, C.L. 1971. Diatoms, the neglected organisms. *The American Biology Teacher* 33(2):98–99.

Christensen C.L. 1976. Notes on Iowa diatoms XI: a study of the genus *Pinnularia* from Dead Man's Lake. *Proceedings of the Iowa Academy of Science* 83:81–87.

Christensen, C.L. and Reimer, C.W. 1968. Notes on the diatom *Cylindrotheca gracilis* (Bréb. ex Kütz.) Grun.: its ecology and distribution. *Proceedings of the Iowa Academy of Science* 75:36–41.

CLARK, R.L. AND RUSHFORTH, S.R. 1977. Diatom studies of the headwaters of Henrys Fork of the Snake River, Island Park, Idaho, U.S.A. *Bibliotheca Phycologica* 33:1–204.

CLARK, W.J. AND SIGLER, W.F. 1961. Preliminary investigation of the phytoplankton of Bear Lake, Utah-Idaho. *Transactions of the American Microscopical Society* 80:28–32.

CLEVE, P.T. 1894. Synopsis of the naviculoid diatoms, Part 1. *Kongelige Svenska Vetenskaps-Akademiens Handlingar* 26:1–194.

CLEVE, P.T. 1895. Synopsis of the naviculoid diatoms, Part 2. *Kongelige Svenska Vetenskaps-Akademiens Handlingar* 27:1–219.

CLEVE, P.T. AND MÖLLER, J.D. 1877. *Diatoms. Exsiccatae.* Part I. no. 1–48. Uppsala, Sweden.

CLEVE, P.T. AND MÖLLER, J.D. 1878a. *Diatoms. Exsiccatae.* Part II. no. 49–108. Uppsala, Sweden.

CLEVE, P.T. AND MÖLLER, J.D. 1878b. *Diatoms. Exsiccatae.* Part III. no. 109–168. Uppsala, Sweden.

CLEVE, P.T. AND MÖLLER, J.D. 1879. *Diatoms. Exsiccatae.* Part V. no. 217–276. Uppsala, Sweden.

COCHRAN-STAFIRA, D.L. AND ANDERSEN, R.A. 1984. Diatom flora of a kettle-hole bog in relation to hydrarch succession zones. *Hydrobiologia* 109:265–273.

COCKERELL, T.D.A. 1888. Colorado algae. *Hardwicke's Science-Gossip* 1888:278.

COFFING, C. 1937. A quantitative study of the phytoplankton of the White River canal, Indianapolis, Indiana. *Butler University Botany Studies* 4:13–31.

COLE, G.A. 1957. Studies on a Kentucky Knobs lake, III. Some qualitative aspects of the net plankton. *Transactions of the Kentucky Academy of Science* 18:88–101.

COLLINGSWORTH, R.F., HOHN, M.H. AND COLLINS, G.B. 1967. Postglacial physicochemical conditions of Vestaburg Bog, Montcalm County, Michigan, based on diatom analyses. *Papers of the Michigan Academy of Science, Arts, and Letters* 52:19–30

COLLINS, G.B. AND KALINSKY, R.G. 1977. Studies on Ohio diatoms: I, Diatoms of the Scioto River basin; II, Referenced checklist of diatoms from Ohio exclusive of Lake Erie and the Ohio River. *Bulletin of the Ohio Biological Survey*, New Series, 5:1–76.

COLLINS, G.B. AND WEBER, C.I. 1978. Phycoperiphyton (algae) as indicators of water quality. *Transactions of the American Microscopical Society* 97:36–43.

CONN, H.W. AND WEBSTER, L.W. 1908. A preliminary report on the algae of the fresh waters of Connecticut. *Connecticut Geological and Natural History Survey, Bulletin* 10:1–78.

COOPER, I.C.G. 1958. A new diatom from Fort Meyer, Florida, U.S.A. *Revue Algologique*, n.s., 4(2):125–128.

COOPER, J.M. AND WILHM, J. 1975. Spatial and temporal variation in productivity, species diversity, and pigment diversity of periphyton in a stream receiving domestic and oil refinery effluents. *The Southwestern Naturalist* 19:413–428.

COUTANT, C.C. 1964. Stream plankton above and below Green Lake reservoir. *Proceedings of the Pennsylvania Academy of Science* 37:122–126.

COWELL, B.C. 1960. A quantitative study of the winter plankton of Urschel's quarry. *Ohio Journal of Science* 60:183–191.

COUCH, G.C. 1941. Hydrogen-ion concentrations and diatoms in certain lakes of the Medicine Bow Mountains of Wyoming. *University of Wyoming Publications* 8:69–83.

CRANE, N.L. AND SOMMERFELD, M.R. 1977. Phytoplankton ecology of Lynx Lake, Arizona. *The Southwestern Naturalist* 22:305–320.

CRAYTON, W.M. AND SOMMERFIELD, M.R. 1979. Composition and abundance in phytoplankton in tributaries of the lower Colorado River, Grand Canyon region. *Hydrobiologia* 66:81–94.

CUNNINGHAM, G.A. AND WHITSON, P.D. 1978. Quantitative character analysis for a new variety of *Synedra cyclopum*. *Journal of Phycology* 14:526–529.

CURTIS, G.H. 1899. Some Diatomaceae of Kansas. *Transactions of the Kansas Academy of Science* 17:68–79.

CURTIS, G.L. 1882(?1883). Diatoms of the waters of Indiana. Pages 377–384 in *12th Annual Report of the Indiana Department of Geology and Natural History.*

CUSHING, C.E., CUMMINS, K.W., MINSHALL, G.W. AND VANNOTE, R.L. 1983. Periphyton, chlorophyll α, and diatoms of the Middle Fork of the Salmon River, Idaho. *Holarctic Ecology* 6:221–227.

CUSHING, C.E. AND RUSHFORTH, S.R. 1984. Diatoms of the Middle Fork of the Salmon River drainage, with notes on their relative abundance and distribution. *Great Basin Naturalist* 44:421–427.

CZARNECKI, D.B. 1979. Epipelic and epilthic diatom assemblages in Montezuma Well National Monument, Arizona. *Journal of Phycology* 15:346–352.

CZARNECKI, D.B. 1981. The diatom flora of the Lower Chevelon Creek area of Arizona: An inland brackish water system. *The Southwestern Naturalist* 26:311–324.

CZARNECKI, D.B. 1994a. The freshwater diatom culture collection at Loras College, Dubuque, Iowa. Pages 155–173 *in* J.P. Kociolek, *Proceedings of the 11th International Diatom Symposium, San Francisco, California, 12–17 August 1990*. Memoirs of the California Academy of Sciences, No. 17. San Francisco, California, USA.

CZARNECKI, D.B. 1994b. Nomenclatural changes for some diatoms found in Iowa. *Journal of the Iowa Academy of Science* 101:96–97.

CZARNECKI, D.B. 1995. Additions and confirmations to the algal flora of Lake Itasca (MN) State Park. III. The intramucilaginous diatom flora of the colonial peritrich ciliate, *Ophrydium versatile* (Ophrydiidae), Pages 183–194 *in* J.P. Kociolek and M.J. Sullivan, eds., *A Century of Diatom Research in North America. A tribute to the distinguished careers of Charles W. Reimer and Ruth Patrick*. Koeltz Scientific Books, Champaign, Illinois, USA.

CZARNECKI, D.B. AND BLINN, D.W. 1977. Diatoms of lower Lake Powell and vicinity. *Bibliotheca Phycologia* 28:1–119.

CZARNECKI, D.B. AND BLINN, D.W. 1978. Observations on southwestern diatoms I. *Plagiotropis arizonica* n. sp. (Bacillariophyta, Entomeidaceae), a large mesohalobous diatom. *Transactions of the American Microscopical Society* 97:393–396.

CZARNECKI, D.B. AND BLINN, D.W. 1978. Diatoms of the Colorado River in Grand Canyon National Park and vicinity. Diatoms of southwestern USA. II. *Bibliotheca Phycologica* 38:1–181.

CZARNECKI, D.B., BLINN, D.W. AND PENTON, M. 1981. The diatom flora of the Lower Chevelon Creek area of Arizona: An inland brackish water system. *The Southwestern Naturalist* 26:311–324.

CZARNECKI, D.B. AND BLINN, D.W. 1979. Observations on southwestern diatoms. II. *Caloneis latiuscula* var. *reimeri, Cyclotella pseudostelligera* f. *parva* and *Gomphonema montezumense* n. sp., new taxa from Montezuma Well National Monument. *Transactions of the American Microsopical Society* 98:110–114.

CZARNECKI, D.B. AND EDLUND, M.B. 1995. New combinations for some taxa of *Achnanthes*. *Diatom Research* 10:207–209.

CZARNECKI, D. AND REINKE, D.C. 1981. Diatoms new to Kansas and nomenclatural notes on previous reports. *Technical Publications of the State Biological Survey of Kansas* 10:20–31.

CZARNECKI, D.B. AND REINECKE, D.L. 1982. Nomenclatural changes among some Kansas diatoms. *Transactions of the Kansas Academy of Science* 85:174–176.

DAILY, W.A. 1938. A quantitative study of the phytoplankton of Lake Michigan collected in the vicinity of Evanston, Illinois. *Butler University Botanical Studies* 4:65–83.

DAILY, W.A. AND MINER, E.E. 1953. The phytoplankton of Lake Wawasee, Koscuisko County, Indiana. *Butler University Botanical Studies* 11:91–99.

DAMANN, K.E. 1940. Phytoplankton studies of Lake Michigan at Evanston, Illinois. *Transactions of the Illinois State Academy of Science* 33:68–70.

DAMANN, K.E. 1941. Quantitative study of the phytoplankton of Lake Michigan at Evanston, Illinois. *Butler University Botany Studies* 5:27–44.

DAMANN, K.E. 1945. Plankton studies of Lake Michigan. I. Seventeen years of plankton data collected at Chicago, Illinois. *American Midland Naturalist* 4:769–796.

DAMANN, K.E. 1960. Plankton studies of Lake Michigan II: Thirty-three years of continuous plankton and coliform bacteria data collected from Lake Michigan at Chicago, Illinois. *Transactions of the American Microscopical Society* 79(4):397–404.

DANFORTH, W.F. AND GINSBURG, W. 1980. Recent changes in the phytoplankton of Lake Michigan near Chicago. *Journal of Great Lakes Research* 6:307–314.

DAVIS, C.C. 1964. Evidence for the eutrophication of Lake Erie from phytoplankton records. *Limnology and Oceanography*. 9:275–283.

DAVIS, C.C. 1966. Plankton studies in the Great Lakes of the world with special reference to the St. Lawrence Great Lakes of North America. *University of Michigan, Great Lakes Research Divsion Publication*

14:1–54.

DAVIS, C.C. 1968. Plants in lakes Erie and Ontario and changes in their numbers and kinds. *Bulletin of the Buffalo Society of Natural Sciences* 25:18–41.

DAVIS, C.O., SCHELSKE, C.L. AND KREIS, R.G., JR. 1980. Influences of spring thermal bar, Section 7. Pages 140–164 *in* C.L. Schelske, R.A. Moll and M.S. Simmons, *Limnological Conditions in Southern Lake Huron, 1974 and 1975*. U.S. Environmental Protection Agency, Office of Research and Development, Duluth, Minnesota. U.S. EPA-600/3-80-074. 177 pp.

DAVID, L.S., HOFFMANN, J.P. AND COOK, P.W. 1990. Seasonal succession of algal periphyton from a wastewater treatment facility. *Journal of Phycology* 26:611–617.

DAVID, J.S., RANDS, D.G. AND HEIN, M.K. 1989. Biota of the tufa deposit of Falling Springs, Illinois, U.S.A. *Transactions of the American Microscopical Society* 108:403–409.

DAYNER, D.M. AND JOHANSEN, J.R. 1991. Observations on the algal flora of Seneca Cavern, Seneca County, Ohio. *Ohio Journal of Science* 91:118–121.

DEMING, J.L. 1888. List of diatoms from Granville, Ohio. *Bulletin of the Science Laboratory of Denison University* 4:114–115.

DENICOLA, D.M., HOAGLAND, K.D. AND ROEMAR, S.C. 1992. Influence of canopy cover on spectral irradiance and periphyton assemblages in a prairie stream. *Journal of the North American Bentholological Society* 11:391–404.

DEYOE, H.R., LOWE, R.L. AND MARKS, J.C. 1992. Effects of nitrogen and phosphorus on the endosymbiont load of *Rhopalodia gibba* and *Epithemia turgida* (Bacillariophyceae). *Journal of Phycology* 28:773–777.

DILLARD, G.E. 1968. The benthic algal communities of a North Carolina piedmont stream. *Nova Hedwigia* 17:9–29.

DILLARD, G.E. 1971. An epilithic diatom community of a North Carolina sandhills stream. *Revue Algologie*, n.s., 10(2):118–127.

DINEEN CF. 1980. Plankton and benthos of Spicer Lake. *Proceedings of the Indiana Academy of Science for 1979*, 89:173–179.

DIXIT, S.S., CUMMING, B.F., BIRKS, H.J.B., SMOL, J.P., KINGSTON, J.C., UUTALA, A.J., CHARLES, D.F. AND CAMBURN, K.E. 1993. Diatom assemblages from Adirondack lakes (New York, USA) and the development of inference models for retrospective environmental assessment. *Journal of Paleolimnology* 8:27–47.

DIXIT, S.S. AND SMOL, J.P. 1995. Diatom evidence of past water quality changes in Adirondack seepage lakes (New York, U.S.A.). *Diatom Research* 10:113–129.

DODD, J.D. 1971. *The Ecology of Diatoms in Hardwater Habitats*. U.S. EPA, Water Pollution Control Research Series, 18050 DIE. 62 pp.

DODD, J.D. AND STOERMER, E.F. 1962. Notes on Iowa diatoms. I. An interesting collection from a moss-lichen habitat. *Proceedings of the Iowa Academy of Science* 69:83–87.

DODD, J.J. 1981. Additions to the diatom flora of Pilot Knob Sphagnum bog, Hancock County, Iowa. *Proceedings of the Iowa Academy of Science* 88:50–51.

DODD, J.J. 1987. *Diatoms. The Illustrated Flora of Illinois*. Southern Illinois University Press, Carbondale, Illinois, USA. 477 pp.

DODDS, W.K. 1991. Community interactions between the filamentous alga *Cladophora glomerata* (L.) Kützing, its epiphytes, and epiphyte grazers. *Oecologia* 85:572–580.

DONAR, C.M., NEELY, R.K. AND STOERMER, E.F. 1996. Diatom succession in an urban reservoir system. *Journal of Paleolimnology* 15:237–243.

DOWNING, E.P. 1973. *Annotated Bibliography of Lake Ontario Limnological and Related Studies*. Volume II. Biology. U.S. EPA-R3-73-028b.

DRUM, R.W. 1962. Notes on Iowa diatoms III. Occurrence of the genus *Pleurosigma* in the Des Moines River. *Proceedings of the Iowa Academy of Science* 69:96–98.

DRUM, R.W. 1963. The cytoplasmic fine structure of the diatom *Nitzchia palea*. *Journal of Cell Biology* 18:429–440.

DRUM, R.W. 1981. Diatoms in the Des Moines River. *Proceedings of the Iowa Academy of Science* 88:52–62.

DRUM, R.W. AND PANKRATZ, H.S. 1964. Pyrenoids, raphes and other fine structure in diatoms. *American Journal of Botany* 51:405–418.

Drum, R.W., Pankratz, H.S. and Stoermer, E.F. 1966. Electron microscopy of diatom cells. *In* J.G. Helmcke and W. Krieger, eds., *Diatomeenschalen im elecktronenmikrosckopischen Bild.* Band VI. J. Cramer Verlag, Lehre, Germany.

Dufford, R.G., Zimmerman, H.J., Cline, L.D. and Ward, J.V. 1987. Response of epilithic algae to regulation of Rocky Mountain streams. Pages 383–390 *in* J.F. Craig and J.B. Kemper, eds., *Regulated Streams: Advances in Ecology.* Plenum Press, New York, USA.

Duncan, S.W. and Blinn, D.W. 1989. Importance of physical variables on the seasonal dynamics of epilithic algae in a highly shaded canyon stream. *Journal of Phycology* 25:455–461.

Duthie, H.C. and Sreenivasa, M.R. 1972. The distribution of diatoms on the surficial sediments of Lake Ontario. Pages 45–52 in *Proceedings of the 15th Conference on Great Lakes Research.* International Association of Great Lakes Research, Ann Arbor, Michigan, USA.

Dute, R.R., Sullivan, M.J. and Shunnarah, L.E. 2000. The diatom assemblages of *Ophrydium* colonies from South Alabama. *Diatom Research* 15:31–42.

Eberle, M.E. 1982. Annotated list of diatoms reported from Kansas. *Fort Hays Studies, Science,* New Series 1:1–145.

Eddy, S. 1924. Presence of living organisms in lake ice. *Transactions of the Illinois State Academy of Science* 17:85–86.

Eddy, S. 1927. The plankton of Lake Michigan. *Illinois Natural History Survey Bulletin* 17(4):203–232.

Eddy, S. 1930. The plankton of Reelfoot Lake, Tennessee. *Transactions of the American Microscopical Society* 49:246–251.

Eddy, S. 1932. The plankton of the Sangamon River in the Summer of 1929. *Bulletin of the Illinois Natural History Survey* 19:469–486.

Eddy, S. 1934. A study of fresh-water plankton communities. *Illinois Biological Monographs* 12:1–93.

Edgar, R.K. 1978. The Jacob Whitman Bailey *Diatom Collection at the Farlow Herbarium [of Harvard University*]. Farlow Herbarium, Cambridge, Massachusetts, USA. iii + 155 pp.

Edgar, R.K. 1987. *Diatoms in Published Exsiccatae at the Farlow Herbarium: Indexes to Taxa, Geographical Localities and Diatomists.* Farlow Herbarium, Cambridge, Massachusetts, USA. (4) + 500 pp.

Edgar, S.M. and Theriot, E.C. 2003. Heritability and mantle areolar characters in *Aulacoseira subarctica* (Bacillariophyta). *Journal of Phycology* 39:1057–1066.

Edmondson, W.T. 1972. Nutrients and phytoplankton in Lake Washington. Pages 172–193 *in* G. Likens, ed., *Nutrients and Eutrophication.* American Society of Limnology and Oceanography Special Symposium No. 1.

Edmondson, W.T. 1977. The recovery of Lake Washington from eutrophication,. Pages 102–109 *in* J. Cairns, Jr., R.L. Dickson, and E.E. Herricks, eds., *Recovery and Restoration of Damaged Ecosystems.* University Press of Virginia, Charlottesville, Virginia, USA.

Edlund, M.B. 1994. Additions and confirmations to the algal flora of Itasca State park II. Diatoms from Chambers Creek. *Journal of the Minnesota Academy of Science* 59:10–21.

Edlund, M.B., Andresen, N.A. and Soninkhishsig, N. 2001. Morphology of *Oestrupia zachariasii* and its transfer to *Biremis. Diatom Research* 16:295–306.

Edlund, M.B. and Brant, L.A. 1997. *Frustulia bahlsii* sp. nov., a freshwater diatom from the eastern U.S.A. *Diatom Research* 12:207–216.

Edlund, M.B. and Stoermer, E.F. 1991. Sexual reproduction in *Stephanodiscus niagarae* (Bacillariophyta). *Journal of Phycology* 27:780–793.

Edlund, M.B. and Stoermer, E.F. 1993. Resting spores of the freshwater diatoms *Acanthoceros* and *Urosolenia. Journal of Paleolimnology* 9:55–61.

Edsall, T.A., Stoermer, E.F. and Kociolek, J.P. 1991. Periphyton accumulation at remote reefs and shoals in Lake Superior. *Journal of Great Lakes Research* 17:412–418.

Edwards, A.M. 1860. On American Diatomaceae. *Quarterly Journal for Microscopical Science* 8:127–129.

Edwards, A.M. 1868. On the occurrence of living forms in the hot waters of California. *American Journal of Sciences and Arts II* 45:239–241.

Edwards, A.M. 1874. Natural history of the Diatomaceae. Pages 416–505 *in* C.H. Hitchcock and J.H.

Huntington, eds., *The Geology of New Hampshire, Part I. Physical Geology*. E.A. Jenks, Concord, New Hampshire.

EDWARDS, A.M. 1890. Diatoms from Keene, New Hampshire. *The Microscope* 10:352.

EDWARDS, M.L. 1974. Notes on diatoms from waters of two drainage tiles in northwest Iowa. *Proceedings of the Iowa Academy of Science* 81:61–67.

EDWARDS, M.L. AND CHRISTENSEN, C.L. 1972. Notes on autumn collections of diatoms from Brewer's Creek, Hamilton County, Iowa. *Proceedings of the Iowa Academy of Science* 79:25–30.

EHRENBERG, C.G. 1843. Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika. *Abhandlungen der königlichen Akademie der Wissenschaften zu Berlin* 1841:291–445.

EHRENBERG, C.G. 1849. Über das mächtigste bis jetzt bekannt gewordene (angeblich 500 Fufs mächtige) Lager von mikroskopichen reinen kieselschaligen Süsswasser-Formen am Wasserfall im Oregon. Bericht über die zur Bekanntmachung geeigneten *Verhandlungen der königlichen Akademie der Wissenschaften zu Berlin* 1849:76–87.

EHRENBERG, C.G. 1849. Über das mikroskopischen Leben in Texas. Bericht über die zur Bekanntmachung geeigneten. *Verhandlungen der königlichen Akademie der Wissenschaften zu Berlin* 1849:87–91.

EHRENBERG, C.G. 1852. Übersicht des mikroskopischen Lebens in Californien und legte die Formen in Präparaten vor. Bericht über die zur Bekanntmachung geeigneten. *Verhandlungen der königlichen Akademie der Wissenschaften zu Berlin* 1852:528–536.

EHRENBERG, C.G. 1853. Über das jetzige mikroskopische Leben als Flufstrübung und Humusland in Florida. Bericht über die zur Bekanntmachung geeigneten *Verhandlungen der königlichen Akademie der Wissenschaften zu Berlin* 1853:252–271.

EHRENBERG, C.G. 1854. *Mikrogeologie. Das Erden und Felsen schaffende Wirken des unsichtbar kleinen selbstständigen Lebens auf der Erde*. Leopold Voss, Leipzig, Germany. 374 pp.

EHRENBERG, C.G. 1856. *Mikrogeologie. Das Erden und Felsen schaffende Wirken des unsichtbar kleinen selbstständigen Lebens auf der Erde. Fortsetzung*. Leopold Voss, Leipzig, Germany. 88 pp.

EHRENBERG, C.G. 1870. Über mächtige Gebirgs-Schichten vorherrschend aus mikroskopischen Bacillarien unter und bei der Stadt Mexiko. *Abhandlungen der. Königlichen Akademie dert Wissenschaften zu Berlin* 1869:1–66.

EKINS, L. AND RUSHFORTH, S.R. 1986. Diatom flora of Cowboy Hot Springs, Mono County, California. *Great Basin Naturalist* 46:612–623.

ELMORE, C.J. 1921. The diatoms (Bacillarioideae) of Nebraska. *University of Nebraska Studies* 21:22–215. (also published in 1922 in *Nebraska Geological Survey Bulletin,* vol. 8. 192 pp.).

ELMORE, C.J. 1922. A comparison of German and American diatoms. *Publications of the Nebraska Academy of Science* 10:65–66.

ESTEP, K.W. AND RAMSEN, C.C. 1983. A new species of *Fragilaria* from the midwestern United States. *Nova Hedwigia* 38:217–221.

EULENSTEIN, T. 1869. *Diatomacearum Species Typicae*. Edition 2, Slides No. 1–100. Dresden, Germany.

EVENSON, W.E., RUSHFORTH, S.R., BROTHERSON, J.D. AND FUNGLADDA, N. 1981. The effects of selected physical and chemical factors on attached diatoms in the Uintah Basin of Utah, USA. *Hydrobiologia* 83:325–330.

EWING, M.S. AND DORRIS, T.C. 1970. Algal community structure in artificial ponds subjected to continuous organic enrichment. *American Midland Naturalist* 83:565–582.

FAHNENSTIEL, G.L. AND CARRICK, H.J. 1988. Primary production in lakes Huron and Michigan: *in vitro* and *in situ* comparisons. *Journal of Plankton Research* 10:1273–1283.

FAHNENSTIEL, G. L., AND GLIME, J.M. 1983. Subsurface chlorophyll maximum and associated *Cyclotella* pulse in Lake Superior. *Internationale Revue gesamten Hydrobiologie* 68:605–616.

FAHNENSTIEL, G.L. AND SCAVIA, D. 1987. Dynamics of Lake Michigan phytoplankton: The deep chlorophyll layer. *Journal of Great Lakes Research* 13:285–295.

FAHNENSTIEL, G.L., SCAVIA, D. AND SCHELSKE, C.L. 1984. Nutrient-light interactions in the Lake Michigan subsurface chlorophyll layer. *Verhandlungen der Internationale Verein Limnologie* 22:440–444.

FAHNENSTIEL, G.L. AND SCAVIA, D. 1987. Dynamics of Lake Michigan phytoplankton: the deep chlorophyll layer. *Journal of Great Lakes Research* 13:285–295.

Fahnenstiel, G.L., Schelske, C.L. and Moll, R.A. 1984. *In situ* quantum efficiency of Lake Superior phytoplankton. *Journal of Great Lakes Research* 10:399–406.

Fairchild, E. and Sheridan, R.P. 1974. A physiological investigation of the hot spring diatom, *Achnanthes exigua* Grun. *Journal of Phycology* 10:1–4.

Fairchild, G.W. and Everett A.C. 1988. Effects of nutrient (N, P, C) enrichment upon periphyton standing crop, species composition and primary production in an oligotrophic softwater lake. *Freshwater Biology* 19:57–70.

Fairchild, G.W. and Lowe, R.L. 1984. Artificial substrates which release nutrients: effects on periphyton and invertebrate succession. *Hydrobiologia* 114:29–37

Fee, E.J. 1965. Diatoms epizoic on copepods parasitizing fishes in the Des Moines River, Iowa. *American Midland Naturalist*. 74(2):318–324.

Fee, E.J. 1967. The diatoms in a small Iowa creek. *Iowa State Journal of Science* 41:393–411.

Feldt, L.E., Stoermer, E.F. and Schelske, C.L. 1973. Occurrence of morphologically abnormal *Synedra* populations in Lake Superior phytoplankton. Pages 34–39 in *Proceedings of the 16th Conference on Great Lakes Research 1973*.

Felix, E.A. 1977. *Zygorhizidium melosirae* parasitizing *Melosira granulata* in Utah Lake, Utah, U.S.A. *Transactions of the British Mycological Society* 69:516–520.

Felix, A.E. and Rushforth, S.R. 1979. The algal flora of the Great Salt Lake, Utah, U.S.A. *Nova Hedwigia* 31:163–195.

Fenwick, M.G. 1968. Lake Huron distribution of *Tabellaria fenestrata* var. *geniculata* A. Cleve and *Coelastrum reticulatum* var. *polychordon* Korshik. *Transactions of the American Microscopical Society* 87:376–383.

Fisher, S.G., Gray, L.J., Grimm, N.B. and Busch, D.B. 1982. Temporal succession in a desert stream ecosystem. *Ecological Monographs* 52:93–110.

Flint, R.W., Richards, R.C. and Goldman, C.R. 1977. Adaptation of styrofoam substrate to benthic algal productivity studies in Lake Tahoe, California-Nevada. *Journal of Phycology* 13:407–409.

Florin, M.B. 1970. Late-glacial diatoms of Kirchner Marsh, southeastern Minnesota. *Nova Hedwigia Beihefte* 31:667–756.

Foerster, J.W. and Schlichting, H.E. 1966. Phycoperiphyton in an oligotrophic lake. *Transactions of the American Microscopical Society* 84:485–502.

Foote, M. 1987. The algae of New Jersey. X. Bacillariophyta (Diatoms). A. Fragilariales. *Phytologia* 63:137–141.

Foote, M. 1987. The algae of New Jersey. XI. Bacillariophyta (Diatoms). B. Eunotiales and Achnanthales. *Phytologia* 63:142–147.

Foote, M. 1987. The algae of New Jersey. XII. Bacillariophyta (Diatoms). C.The occurrence of *Cylindrotheca gracilis* (Bréb. ex Kütz.) Grun. in the Hackensack River estuary. *Phytologia* 63:148–152.

Fontaine, T.D., III, and Nigh, D.G. 1980. Characteristics of epiphyte communites on natural and artificial submersed lotic plants: substrate effects. *Archiv für Hydrobiologie* 96:293–301.

Fox, J.L., Odlaug, T.O. and Olson, T.A. 1969. *The Ecology of Periphyton in Western Lake Superior; Part I—Taxonomy and Distribution*. Water Resources Research Center Bulletin 14, University of Minnesota, Minneapolis, Minnesota, USA. 127pp

Freedman, P.L. 1974. *Saginaw Bay: An Evaluation of Existing and Historical Conditions*. U.S. Environmental Protection Agency, Region V, Chicago, Illinois, USA. 137 pp.

Funk, W.H. and Gaufin, A.R. 1967. Phytoplankton productivity in a Wyoming cooling-water reservoir. Pages 167–178 *in* G.E. Hall, ed., *Reservoir Fisheries and Limnology*. American Fisheries Society, Special Publication 8. Washington, DC, USA.

Gaiser, E.E. and Bachmann, R.W. 1993. The ecology and taxonomy of epizoic diatoms on *Cladocera*. *Limnology and Oceanography* 38:628–637.

Gaiser, E.E. and Bachmann, R.W. 1994. Seasonality, substrate preference and attachment sites of epizoic diatoms on cladoceran zooplankton. *Journal of Plankton Research* 16:53–68.

Gaiser, E.E. and Johansen, J. 2000. Freshwater diatoms from Carolina Bays and other isolated wetlands on the Atlantic coastal plain of South Carolina, U.S.A., with descriptions of seven taxa new to science.

Diatom Research 15:75–130.

GALE, W.F., GURZYNSKI, A.J. AND LOWE, R.L. 1979. Colonization and standing crops of epilithic algae in the Susquehanna River, Pennsylvania. *Journal of Phycology* 15:117–123.

GANNON, J.E. 1969. *Great Lakes Plankton Investigations: A Bibliography*. University of Wisconsin-Milwaukee, Center for Great Lakes Studies Special Report No. 7. 65 pp.

GARONO, R.J., HEATH, R.T. AND HWANG, S.-J. 1996. Dentrended correspondence analysis of photoplankton (sic) abundance and distribution in Sandusky Bay and Lake Erie. *Journal of Great Lakes Research* 22:818–829.

GASHWILER, K. AND DODD, J.D. 1961. Algae from the warm pools of Silver Lake Fen. *Proceedings Iowa Academy of Science* 68:129–131.

GAUFIN, A.R. AND MCDONALD, D.B. 1965. Factors influencing algal productivity in Deer Creek Reservoir, Utah. *Transactions of the American Microscopical Society* 84:269–279.

GAUFIN, A.R., PRESCOTT, G.W. AND TIBBS, J.F. 1976. Limnological studies of Flathead Lake, Montana: A status report. United States Environmental Protection Agency, Ecological Research Series, EPA-600/3-76-039. Corvallis, Oregon, USA. 85 pp.

GLOOSHENKO, W.A. AND ALVIS, C. 1973. Changes in species composition of phytoplankton due to enrichment by N, P and Si of water from a North Florida lake. *Hydrobiologia* 42:285–294.

GOLDMAN, C.R. 1974. *Eutropication of Lake Tahoe Emphasizing Water Quality*. United States Environmental Protection Agency, EPA-660/3-74-034. Corvallis, Oregon, USA. 408 pp.

GOODWIN, H.A. 1943. Plankton of the lakes and ponds. Pages 56–66 in *A Biological Survey of Lakes and Ponds of the Central Coastal Area of Maine*. Maine Department of Inland Fisheries and Game. Fish Survey Report 5.

GOTTSCHALL, R.Y. 1930. Preliminary report on the phytoplankton and pollution in Presque Isle Bay, Lake Erie. *Proceedings of the Pennsylvania Academy of Science* 4:1–11.

GOTTSCHALL, R.Y. AND JENNINGS, O.E. 1933. Limnological studies at Erie, Pennsylvania. *Transactions of the American Microscopical Society* 52:181–191.

GRAY, I.M. 1987. Difference between nearshore and offshore phytoplankton communities in Lake Ontario. *Canadian Journal of Fisheries and Aquatic Science* 44:2155–2163.

GREENLEAF, R.C. 1866. On new species of *Nitzschia* (*N. mitchelliana*). *Proceedings of the Boston Society of Natural History* 10:107–108.

GREENLEAF, R.C. 1868. List of diatomaceae found in a peat swamp near Lake Winisquam in Laconia, N.H. *Proceedings of the Boston Society of Natural History* 11:75.

GRIFFITH, M.B., BOLCH, C.J.S., GREEN, D.H., CEMBELLA, A.D. AND TEO, S.L.M. 2002. Multivariate analysis of periphyton assemblages in relation to environmental gradients in Colorado Rocky Mountain streams. *Journal of Phycology* 38:83–95.

GRIMES, J.A., CUSHING, C.E. AND RUSHFORTH, S.R. 1984. Diatoms of the Middle Fork of the Salmon River drainage, with notes on their relative abundance and distribution. *Great Basin Naturalist* 44:421–427

GRIMES, J.A. AND RUSHFORTH, S.R. 1982. Diatoms of recent bottom sediments of Utah Lake Utah, U.S.A. *Bibliotheca Phycologia* 55:1–179.

GRIMES, J.A. AND RUSHFORTH, S.R. 1983. Diatoms of surface sediments of Utah Lake, Utah, USA. *Hydrobiologia* 99:161–174

GRIMES, J.A., RUSHFORTH, S.R., BROTHERSON, J.D. AND EVENSON, W.E. 1984. Diatoms in recent bottom sediments and trophic status of eight lakes and reservoirs in Northeastern Utah. *Great Basin Naturalist* 44:36–48.

GRIMES, J.A., ST. CLAIR, L.L. AND RUSHFORTH, S.R. 1980. A comparison of epiphytic diatom assemblages on living and dead stems of the common grass *Phragmites australis*. *Great Basin Naturalist* 40(3):223–228.

GRUENDLING, G.K. AND MATHIESON, A.C. 1969a. Phytoplankton flora of Newfound and Winnisquam lakes, New Hampshire. *Rhodora* 71:444–477.

GRUENDLING, G.K. AND MATHIESON, A.C. 1969b. *Phytoplankton Populations in Relation to Trophic Levels of Lakes in New Hampshire, U.S.A.* Water Resources Research Center, University of New Hampshire, Number 1. Durham, New Hampshire, USA. 81 pp.

GRUNOW, A. 1878. Algen und Diatomaceen aus dem Kaspichen Meere. Pages 98–133 *in* O. Schneider, ed.,

Naturwissenschaftliche Beitrage zur Kenntnis der Kaukasusländer, auf Grund seiner Sammelbeute. Veröffentlicht von der Naturwissenschaft Gesellschaft "Isis" zu Dresden.

GRZENDA, A. AND BALL, R.C. 1968. Periphyton production in a warmwater stream. *Quarterly Bulletin of the Michigan Agricultural Experiment Station* 59:296–303.

GUDMUNDSON, B.J.R. 1972. Plankton algae of the upper Des Moines River, Iowa. *Proceedings of the Iowa Academy of Science* 79:1–6.

GUMTOW, R.B. 1955. An investigation of the periphyton in a riffle of the West Gallatin River, Montana. *Transactions of the American Microscopical Society* 74:278–292.

HAINS, J.J., JR., AND SEBRING, M.M. 1981. Description and distribution of *Synedra planktonica* n. sp. (Bacillariophyceae). *Transactions of the American Microscopical Society* 100:159–164.

HÅKANSSON, H. 1981. *Stephanodiscus* Ehrenberg 1846, a revision of the species described by Ehrenberg. *Nova Hedwigia* 35:117–150.

HÅKANSSON, H. 2002. A compilation and evaluation of species in the general [*sic*] *Stephanodiscus*, *Cyclostephanos* and *Cyclotella* with a new genus in the family Stephanodiscaceae. *Diatom Research* 17:1–139.

HÅKANSSON, H. AND KLING, H. 1990. The current status of some very small freshwater diatoms of the genera *Stephanodiscus* and *Cyclostephanos*. *Diatom Research* 5(2):273–287.

HÅKANSSON, H., THERIOT, E.C. AND STOEMER, E.F. 1986. Morphology and taxonomy of *Stephanodiscus vestibulis* sp. nov. *Nordic Journal of Botany* 6:501–505.

HÅKANSSON, H., AND LOCKER, S. 1981. *Stephanodiscus* Ehrenberg 1846, a revision of the species described by Ehrenberg. *Nova Hedwigia Beihefte* 35:117–150.

HÅKANSSON, H., AND STOERMER, E.F. 1984. An investigation of the morphology of *Stephanodiscus alpinus* Hust. *Bacillaria* 7:159–172.

HAMILTON, P.B., DOUGLAS, M.S. V., FRITZ, S.C., PIENITZ, R., SMOL, J.P. AND WOLFE, A.P. 1994. A compiled freshwater diatom taxa list for the Arctic and Subarctic regions of North America. *Canadian Technical Reports—Fisheries and Aquatic Sciences* 1957:85–102.

HAMILTON, P.B. AND LAIRD, K.R. 2001. *Nitzschia pseudosinuata* sp. nov., a new Holocene diatom from the sediments of Moon Lake, North Dakota, U.S.A. *Diatom Research* 16:317–324.

HAMILTON, P.B., MCNEELY, R. AND POULIN, M. 1996. The morphology and distribution of *Neidium distincte-punctatum* Hustedt and its systematic position within the genus. *Diatom Research* 11:59–71

HAMILTON, P.B., AND POULIN, M. 1993. A taxonomic and morphological study of an acidobiontic diatom, *Neidium holstii* (Cleve) Krammer from North America and Greenland. *Nova Hedwigia Beihefte* 106:109–119.

HAMILTON, P.B., POULIN, M., CHARLES, D.F. AND ANGELL, M. 1992. Americanarum Diatomarum Exsiccatae: CANA, voucher slides from eight acidic lakes in northeastern North America. *Diatom Research* 7:25–36.

HAMILTON, P.B., POULIN, M. AND TAYLOR, M.C. 1990. *Neidium alpinum* var. *quadripunctatum* (Hustedt) comb. nov. an important acidobiontic taxon from northeastern North America. *Diatom Research* 5:289–299.

HAMILTON, P.B., POULIN, M., AND WALKER, D. 1995. *Neidium hitchkockii* (Ehrenberg) Cleve, a morphologically complex taxon within the genus *Neidium* (Naviculales, Bacillariophyta). Pages 61–77 *in* J.P. Kociolek and M.J. Sullivan, eds., *A Century of Diatom Research in North America: A Tribute to the Distinguished Careers of Charles W. Reimer and Ruth M. Patrick*. Koeltz Scientific Books, Champaign, Illinois, USA.

HANNA, G D. AND GRANT, W.M. 1931. Diatoms from Pyramid Lake, Nevada. *Transactions of the American Microscopical Society* 50:282–297.

HANSMANN, E.W. 1973. Diatoms of the streams of eastern Connecticut. *State Geological and Natural History Survey of Connecticut, Bulletin* 106:1–119.

HARDING, W.J. 1970. A preliminary report on the algal species presently found in Utah Lake. *Great Basin Naturalist* 30:99–105.

HARDING, W.J. 1971. The algae of Utah Lake. Part II. *Great Basin Naturalist* 31:125–134.

HARDWICK, G.G., BLINN, D.W. AND USHER, H.D. 1992. Epiphytic diatoms on *Cladophora glomerata* in the Colorado River, Arizona: longitudinal and vertical distribution in a regulated river. *The Southwestern Naturalist* 37:148–156.

HARRIS, B.B. AND SILVEY, J.K.G. 1940. Limnological investigation on Texas reservoir lakes. *Ecological*

Monographs 10:111–143.

Harris, M.R., and Eberle, M.E. 2001. Diatoms (Bacillariophyta) from saline waters within Quivira National Wildlife Refuge, Stafford County, Kansas. *The Southwestern Naturalist* 46:200–207.

Hartig, J.H. 1987. Factors contributing to development of *Fragilaria crotonensis* Kitton pulses in Pigeon Bay waters of western Lake Erie. *Journal of Great Lakes Research* 13:65–77.

Hartman, R.T. 1965. Composition and distribution of phytoplankton communities in the Upper Ohio River. *Pymatuning Laboratory of Ecology, Special Publication* 3:45–65.

Hartman, R.T. and Graffius, J.H. 1960. Quantitative seasonal changes in the phytoplankton communites of Pymatuning Reservoir. *Ecology* 41:333–340.

Hartman, R.T. and Himes, C.L. 1961. Phytoplankton from Pymatuning Reservoir in downstream areas of the Shenango River. *Ecology* 42:180–183.

Harvey, F.L. 1888. The freshwater algae of Maine. I. *Bulletin of the Torrey Botanical Club* 15:155–161.

Harvey,F.L. 1889. The freshwater algae of Maine. II. *Bulletin of the Torrey Botanical Club* 16:181–188.

Harvey, F.L. 1892. The freshwater algae of Maine. III. *Bulletin of the Torrey Botanical Club* 19:118–125.

Hasle, G.R. 1977. Morphology and taxonomy of *Actinocyclus normanii* f. *subsalsa* (Bacillariophyceae). *Phycologia* 16:321–328.

Hasle, G.R. 1978. Some freshwater and brackish water species of the diatom genus *Thalassiossira* Cleve. *Phycologia* 17:263–292.

Hasle, G.R. and Evensen, D.L. 1976. Brackish water and freshwater species of the diatom genus *Skeletonema*. II. *Skeletonema potamos* comb. nov. *Journal of Phycology*. 12:73–82

Hayek, J.M. and Hulbary, W. 1956. A survey of soil diatoms. *Proceedings of the Iowa Academy of Science* 63:327–338.

Heiden, H. 1903. Plates 242–244 *in* A. Schmidt, ed., *Atlas der Diatomaceen-kunde*. O. Reisland, Lepzig, Germany. 480 plates.

Hein, M.K. 1981. Variability in the diatom *Fragilaria floridana* Hanna. *Proceedings of the Iowa Academy of Science* 88:79–81.

Hein, M.K. 1991. *Anorthoneis dulcis* sp. nov., a new freshwater diatom from Northern Florida, U.S.A. *Diatom Research* 6:267–280.

Henry, G. 1914. On the vertical distribution of the plankton in Winona Lake. *Proceedings of the Indiana Academy of Science* 1913:77–92.

Herbst, D.B. and Bradley, T.J. 1989. Salinity and nutrient limitations on growth of benthic algae from two alkaline salt lakes of the western Great Basin (USA). *Journal of Phycology* 25:673–678.

Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Morris, M.K., Williams, L.R., Taylor, W.D. and Hiatt, F.A. 1977. *Distribution of Phytoplankton in South Carolina Lakes*. U.S. EPA-600/3-77-102. Ecological Research Series. 64 pp.

Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Morris, M.K., Williams, L.R., Taylor, W.D. and Hiatt, F.A. 1978. *Distribution of Phytoplankton in Delaware Lakes*. U.S. EPA-600/3-78-027. Ecological Research Series. 33 pp.

Hern, S.C., Lambou, V.W., Morris, F.A., Morris, M.K., Taylor, W.D. and Williams, L.R. 1978. *Phytoplankton Water Quality Relationships in U.S. Lakes, Part III*: Genera *Dactylococcopsis* through *Gyrosigma* collected from eastern and southeastern lakes. National Eutrophication Survey Working paper No. 707. US E.P.A., Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. 116 pp.

Hern, S.C., Lambou, V.W., Morris, F.A., Morris, M.K., Taylor, W.D. and Williams, L.R. 1979. *Distribution of Phytoplankton in Oklahoma Lakes*. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. Report No. EPA 600/3-79-068. 50 pp.

Hickel, B. and Håkansson, H. 1991. The freshwater diatom *Aulacoseira herzogii*. *Diatom Research* 6:299–305.

Hill, W.R. and Knight, A.W. 1988. Nutrient and light limitation of algae in two northern California streams. *Journal of Phycology* 24:125–132.

Hirsch, A. and Palmer, C.M. 1958. Some algae from the Ohio River drainage basin. *Ohio Journal of Science* 58:375–382.

Hiatt, F.A., Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Morris, M.K., Williams, L.R. and

Taylor, W.D. 1977. *Distribution of Phytoplankton in Pennsylvania Lakes*. U.S. EPA Working paper 689. Ecological Research Series. 74 pp.

Hiatt, F.A., Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Morris, M.K., Williams, L.R. and Taylor, W.D. 1978. *Distribution of Phytoplankton in Tennessee Lakes*. U.S. EPA-600/78-016. Ecological Research Series. 67 pp.

Hilgert, J.W., Lambou, V.W., Morris, F.A., Thomas, R.W., Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A. and Hern, S.C. 1977. *Distribution of Phytoplankton in Virginia Lakes*. U.S. EPA-600/3-77-100, Ecological Research Series. 40 pp.

Hilgert, J.W., Lambou, V.W., Morris, F.A., Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A. and Hern, S.C. 1978. *Distribution of Phytoplankton in Ohio Lakes*. U.S. EPA-600/3-78-015, Ecological Research Series. 94 pp.

Hill, W.R. and Knight, A.W. 1988. Nutrient and light limitation of algae in two northern California streams. *Journal of Phycology* 24:125–132.

Hitchcock, R. 1892. Diatoms from new localities. *American Monthly Microscopical Journal* 13:42–43.

Hoagland, K.D. 1983. Short-term standing crop and diversity of periphytic diatoms in a eutrophic reservoir, *Journal of Phycology* 19:30–38.

Hoagland, K.D. and Peterson, C.G. 1990. Effects of light and wave disturbance on vertical zonation of attached microalgae in a large reservoir. *Journal of Phycology* 26:450–457.

Hoagland, K.D. and Rosowski, J.R. 1978. Valve and band morphology of some freshwater diatoms. I. *Fragilaria capucina* var. *mesolepta*. *Journal of Phycology* 14:479–485.

Hoagland, K.D., Roemer, S.C. and Rosowski, J.R. 1982. Colonization and community structure of two periphyton assemblages, with emphasis on the diatoms (Bacillariophyceae). *American Journal of Botany* 69:188–213.

Hobby, C.F.M. 1880. List of species of fresh water algae found in Iowa. *Proceedings of the Iowa Academy of Science* 1875–1880:28.

Hohn, M.H. 1950. The vegetation of Bergen swamp. V. The diatoms. *Proceedings of the Rochester Academy of Science* 9:265–276.

Hohn, M.H. 1951. A study of the distribution of diatoms (Bacillarieae) in western New York State. *Memoirs of the Cornell Agricultural Experimental Station* 308:1–39.

Hohn, M.H. 1952. Contributions to the diatoms of western New York State. *Transactions of the American Microscopical Society* 71:270–271.

Hohn, M.H. 1961. The relationship between species diversity and population density in diatom populations from Silver Springs, Florida. *Transactions of the American Microscopical Society* 80:140–165.

Hohn, M.H. 1969. Qualitative and quantitative analyses of plankton diatoms, Bass Island area, Lake Erie, 1938–1965, including synoptic surveys of 1961–1963. *Ohio Biological Survey*, New Series 3:1–211.

Hohn, M.H. and Hellerman, J. 1963. The taxonomy and structure of diatom populations from three eastern North American rivers using three sampling methods. *Transactions of the American Microscopical Society* 82:250–329.

Holland, R.E. 1965. Planktonic diatoms in Lake Superior. Pages 96–105 *in* University of Michigan, Great Lakes Research Division, *Publication 13*. Ann Arbor, Michigan, USA.

Holland, R.E. 1968. Correlation of *Melosira* spp. with trophic conditions in Lake Michigan. *Limnology and Oceanography* 13:555–557.

Holland, R.E. 1969. Seasonal fluctuations of Lake Michigan diatoms. *Limnology and Oceanography* 14:423–436.

Holland, R.E. and Beeton, A.M. 1972. Significance to eutrophication of spatial differences in nutrients and diatoms in Lake Michigan. *Limnology and Oceanography* 17:88–96.

Holland, R.E. and Claflin, L.W. 1975. Horizontal distribution of planktonic diatoms in Green Bay, mid-July 1970. *Limnology and Oceanography* 20:365–378.

Holm-Hansen, O. Goldman, C.R., Richards, R. and William, P.M. 1976. Chemical and biological characteristics of a water column in Lake Tahoe. *Limnology and Oceanography* 21:548–562.

Hopkins, A.W. and Darby, S.J. 1979. Phytoplankton flora of northern Lake Arlington, Texas. *Texas Journal of Science* 31:239–246.

HOSTETTER, H.P. 1967. Planktonic diatoms in three southern Arizona lakes. *Journal of Arizona Academy of Science* 5:135–139.

HOSTETTER, H.P. AND STOERMER, E.F. 1968. A study of the vertical distribution of periphyton diatoms in Lake West Okoboji, Iowa. *Proceedings of the Iowa Academy of Science* 75:42–47.

HOSTETTER, H.P. AND E.F. STOERMER. 1971. Bibliography on the Bacillariophyceae. Pages 784–790 *in* J.R. Rosowski and B.C. Parker, eds., *Selected Papers in Phycology*. University of Nebraska Press, Lincoln, Nebraska, USA.

HOSTETTER, H.P. AND HOSHAW, R.W. 1972. Asexual developmental patterns of the diatom *Stauroneis anceps* in culture. *Journal of Phycology* 8:289–296.

HOSTETTER, H.P. AND RUTHERFORD, K.D. 1976. Polymorphism of the diatom *Pinnularia brebissonii* in culture and a field collection. *Journal of Phycology* 12:140–146.

HUFF, D.R. 1986. Phytoplankton communities in Navigation Pool No. 7 of the upper Mississippi River. *Hydrobiologia* 136:47–56.

HUFFORD, T.L. AND COLLINS, G.B. 1976. Distribution patterns of diatoms in Cedar Run. *Ohio Journal of Science* 76:172–184

HUFFORD, T.L. AND COLLINS, G.B. 1972. The freshwater diatom *Cymbella cursiformis* nom. nov. *Journal of Phycology* 8:184–187.

HUFFORD, T.L. AND COLLINS, G.B. 1972. Some morphological variations in the diatom *Cymbella cistula*. *Journal of Phycology* 8:192–195.

HUFFORD, T.L. AND COLLINS, G.B. 1972. The stalk of the diatom *Cymbella cistula*: SEM observations. *Journal of Phycology* 8:208–210.

HUNGERFORD, J.J. 1971. Diatoms from seven Iowa rivers. *Iowa State Journal of Science* 46:375–379.

HUNGERFORD, J.J. 1971. Some diatoms in lacustrine sediments of Pillsbury and Sylvan Lake beds in northwest Iowa. *Proceedings of the Iowa Academy of Science* 78:57–62.

HUSTEDT, F. 1912. Plates 281–284 *in* A. Schmidt, ed., *Atlas der Diatomaceen-kunde*. O. Reisland, Lepzig, Germany. 480 plates.

HUSTEDT, F. 1924. Plates 349–352 *in* A. Schmidt, ed., *Atlas der Diatomaceen-kunde*. O. Reisland, Lepzig, Germany. 480 plates.

HUSTEDT, F. 1930. Plates 369–372 *in* A. Schmidt, ed., *Atlas der Diatomaceen-kunde*. O. Reisland, Lepzig, Germany. 480 plates.

HUSTEDT, F. 1931. Plates 373–376 *in* A. Schmidt, ed., *Atlas der Diatomaceen-kunde*. O. Reisland, Lepzig, Germany. 480 plates.

HUSTEDT, F. 1933a. Die Kieselalgen Deutschlands, Österreichs und der Schweiz unter Berüchsichtgung der Übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Pages 321–576 *in* L. Rabenhorst "*Kryptogamen-Flora von Deutschalnd, Österreich und der Schweiz,*" Band 7, Teil 2, Lief 3–4. Akademische Verlagsgesellschaft m.b.h. Leipzig, Germany.

HUSTEDT, F. 1933b. Plates 381–384 *in* A. Schmidt, ed., *Atlas der Diatomaceen-kunde*. O. Reisland, Lepzig, Germany. 480 plates.

HUSTEDT, F. 1934. Plates 385–392 *in* A. Schmidt, ed., *Atlas der Diatomaceen-kunde*. O. Reisland, Lepzig, Germany. 480 plates.

HUSTEDT, F. 1955. Neue und wenig bekannte Diatomeen 8. *Abhandlungen Naturwissenschafte Verein zu Bremen* 34: 47–68.

HUSTEDT, F. 1959. Die Kieselalgen Deutschlands, Österreichs und der Schweiz unter Berüchsichtgung der Übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Pages 737–845 *in* L. Rabenhorst "*Kryptogamen-Flora von Deutschalnd, Österreich und der Schweiz,*" Band 7, Teil 2, Lief 6. Akademische Verlagsgesellschaft m.b.h. Leipzig, Germany.

HUSTEDT, F. 1962. Die Kieselalgen Deutschlands, Österreichs und der Schweiz unter Berüchsichtgung der Übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Pages 161–348 *in* L. Rabenhorst "*Kryptogamen-Flora von Deutschalnd, Österreich und der Schweiz,*" Band 7, Teil 3, Lief 2. Akademische Verlagsgesellschaft m.b.h. Leipzig, Germany.

HUSTEDT, F. 1966. Die Kieselalgen Deutschlands, Österreichs und der Schweiz unter Berüchsichtgung der Übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Pages 557–816 *in* L. Rabenhorst

"*Kryptogamen-Flora von Deutschalnd, Österreich und der Schweiz,*" Band 7, Teil 3, Lief 4. Akademische Verlagsgesellschaft m.b.h. Leipzig, Germany.

Hutchinson, G.E. 1944. Limnological studies in Connecticut VII. A critical examination of the supposed relationship between phytoplankton periodicity and chemical changes in lake water. *Ecology* 25:3–26.

Hutchinson, G.E. 1967. *A Treatise on Limnology. Vol. II. Introduction to Lake Biology and the Limnoplankton.* John Wiley and Sons, New York, USA. 1115 pp.

Inch, D. and Blinn, D.W. 1981. Limnology of Little Park Lake and diatom distribution on the Kaubab Plateau, Arizona. *Journal of the Arizona-Nevada Academy of Science* 1:14–21.

Institute of Water Research, Michigan State University. 1976. *The Impact of Thermal Discharge from the Monroe Power Plant on the Aquatic Community in Western Lake Erie.* Institute of Water Research, Technical Report 32.6. Michigan State University, East Lansing, Michigan, USA.

International Joint Commission (IJC). 1976. *The Waters of Lake Huron and Lake Superior. Vol. I. Summary and Recommendations.* Report to IJC by Upper Lakes Reference Group. Windsor, Ontario, Canada. 236 pp.

International Joint Commission (IJC). 1977. *The Waters of Lake Huron and Lake Superior. Vol. III (Part B).* Lake Superior Report to the IJC by Upper Great Lakes Reference Group. Windsor, Ontario, Canada. Pp. 245–572.

International Joint Commission (IJC). 1980. *Report on Great Lakes Water Quality.* Great Lakes Water Quality Board, Windsor, Ontario, Canada. 68 pp.

Jackson, D.C. and Lowe, R.L. 1978. Valve ultrastructure of the diatom genera *Gyrosigma* and *Pleurosigma* from the Portage River drainage system, Ohio. *Transactions of the American Microscopical Society* 97:569–581.

Jackson, D.F., Nemerow, N.L. and Rand, M.C. 1964. Ecological investigations of the Oswego River drainage basin. *Proceedings of the 7th Conference on Great Lakes Research* 11:88–99.

Jacobs, J.E. 1968. A preliminary checklist of freshwater algae in South Carolina. *Journal of the Elisha Mitchell Scientific Society* 84:454–457.

Jacoby, J.M. 1987. Alterations in periphyton characteristics due to grazing in a Cascade foothill stream. *Freshwater Biology* 18:495–508.

Jatkar, S.A., Rushforth, S.R. and Brotherson, J.D. 1979. Diatom floristics and succession in a peat bog near Lily Lake, Summit County, Utah. *Great Basin Naturalist* 39:15–43.

Jeliffe, S.E. 1893. The Chicago Water-Suppy in the World's Fair Grounds. *American Monthly Microscopical Journal* 14:310–311.

Jeliffe, S.E. 1893. A preliminary report upon the microscopical organisms found in the Brooklyn water supply. *Brooklyn Medical Journal* 7:593–617.

Jeliffe, S.E. 1895. Cryptogamic notes from Long Island. III. Diatomaceae. *Bulletin of the Torrey Botanical Club* 22:274–275.

Johansen, J.R. 1985. Cryptogamic soil crusts: seasonal variation in algal populations in the Tintic Mountains, Juab County, Utah. *Great Basin Naturalist* 45:14–21.

Johansen, J.R., Javakul, R.A. and Rushforth, S.R. 1982. Effects of burning on the algal communities of a high desert soil near Wallsburg, Utah. *Journal of Range Management* 35:598–600.

Johansen, J.R., Lowe, R., Gomez, S.R., Kociolek, J.P., and Makosky, S.A. 2004. New algal species records for the Great Smoky Mountains National Park, U.S.A., with an annotated checklist of all reported algal species for the park. *Algological Studies* 111:17–44.

Johansen, J.R. and Rushforth, S.R. 1981. Diatoms of surface waters and soils of selected oil shale lease areas of eastern Utah. *Nova Hedwigia* 34:333390.

Johansen, J.R., Rushforth, S.R. and Brotherson, J.D. 1981. Subaerial algae of Navajo National Monument. *Great Basin Naturalist* 41:433–439.

Johansen, J.R., Rushforth, S.R. and Brotherson, J.D. 1983. The algal flora of Navajo National Monument, Arizona, U.S.A. *Nova Hedwigia* 38:501–553.

Johansen, J.R., Rushforth, S.R. and Kaczmarska, I. 1982. Algal populations in Bottle Hollow Reservoir, Duchesne County, Utah. *Great Basin Naturalist* 42:205–218.

Johansen, J.R., Rushforth, S.R., Orbendorfer, R., Fungladda, N. and Grimes, J.A. 1983. The algal flora

of selected wet walls in Zion National Park, Utah, USA. *Nova Hedwigia* 38:765–808.

Johansen, J.R. and Sray, J.C. 1998. *Microcostatus* gen. nov., a new aerophilic diatom genus based on *Navicula krasskei* Hustedt. *Diatom Research* 13:93–101.

Johnson, M.W. 1949. Relation of plankton to hydrographic conditions in Sweetwater Lake. *Journal of the American Water Works Association* 41:347–351.

Johnson, R., Richards, T. and Blinn, D.W. 1975. Investigation of diatom populations in rhithron and potamon communities in Oak Creek, Arizona. *The Southwestern Naturalist* 20:197–204.

Johnston, E.M. and Stoermer, E.F. 1976. Computer analysis of phytoplankton cell images. *The Microscope* 248:181–187.

Jordan, R.A. and Bender, M.E. 1973. *An in situ Evaluation of Nutrient Effects in Lakes*. Project 16010 HIU, Ecological Research Series, EPA-R3-73-018, Office of Research and Monitoring, United States Environmental Protection Agency, Washington, DC, USA. 228 pp.

Jordan, R.A. and Bender, M.E. 1973b. Stimulation of phytoplankton growth by mixtures of phosphate, nitrate, and organic chelators. *Water Research* 7:189–195.

Jordan, T.L. and Staley, J.T. 1976. Electronmicroscope study of succession in the periphyton community of Lake Washington. *Microbial Ecology* 2:241–251.

Kaczmarska, I. and Rushforth S.R. 1982. Diatom associations in Blue Lake Warm Spring, Tooele County, Utah, USA. Pages 345–358 *in* D.G. Mann, ed., *Proceedings of the 7th International Diatom Symposium*. O. Koeltz, Koenigstein, Germany. 541 pp.

Kaczmarska, I. and Rushforth, S.R. 1983a. Notes on a rare inland *Hyalodiscus*. *Bacillaria* 6:157–164

Kaczmarska, I. and Rushforth, S.R. 1983b. The diatom flora of Blue Lake Warm Spring, Utah, U.S.A. *Bibliotheca Diatomologica* 2:1123.

Kaczmarska, I., Rushforth, S.R. and Johansen, J.R. 1985. *Chaetoceros amanita* Cleve-Euler (Bacillariophyceae) from Blue Lake Warm Spring, Utah, USA. *Phycologia* 24:103–109

Kalinsky, R.G. 1979. Notes on Louisiana diatoms. I. Rare and unusual periphytic diatoms in Cypress Bayou Reservoir, Bossier Parish, Louisiana. *Proceedings of the Louisiana Academy of Sciences* 42:62–68.

Kalinsky, R.G. 1982. Notes on Louisiana diatoms. II. A preliminary checklist of the diatom flora of Cypress Bayou Reservoir, Bossier Parish, Louisiana. *Proceedings of the Louisiana Academy of Sciences* 45:124–127.

Kalinsky, R.G. 1983. Notes on Louisiana algae. II. A checklist of the non-marine algal flora of Louisiana. *Proceedings of the Louisiana Academy of Sciences* 46:62–96.

Keilty, T.J., Stoermer, E.F. and White, D.S. 1988. Algal remains in some surface sediments of Lake Erie. *Journal of Great Lakes Research* 14:164–170.

Keithan, E.D. and Lowe, R.L. 1985. Primary productivity and spatial structure of phytolithic growth in streams in the Great Smoky Mountains National Park. *Hydrobiologia* 123:59–67.

Keithan, E.D., Lowe, R.L. and DeYoe, H.R. 1988. Benthic diatom distribution in a Pennsylvania stream: role of pH and nutrients. *Journal of Phycology* 24:581–585.

Kellicott, D.S. 1878. Notes on the microscopic life in the Buffalo water supply. *American Journal of Microscopy and Popular Science* 3:250–252.

Kelly, M.H., Fitzpatrick, L.C. and Pearson, W.D. 1978. Phytoplankton dynamics, primary productivity and community metabolism in a north-central Texas pond. *Hydrobiologia* 58:245–260.

Kennedy, M.T. and Pfiester, L. 1984. New additions to the diatom (Bacillariophyceae) flora of Oklahoma. *Proceedings of the Oklahoma Academy of Science* 64:37–39.

Kidd, D.E. 1964. A quantitative analysis of phytoplankton along a Rocky Mountain divide transect. *Transactions of the American Microscopical Society* 83:409–420.

Kiefer, D.A., Holm-Hansen, O., Goldman, G.R., Richards, R. and Berman, T. 1972. Phytoplankton in Lake Tahoe: Deep-living populations. *Limnology and Oceanography* 17:418–422.

Kingsbury, J. 1968. Review oft the algal literature from New York State. Pages 525–541 *in* D.F. Jackson, ed., *Algae, Man and Environment*. Syracuse University Press, Syracuse, New York, USA.

Kingston, J.C. 1978. Morphological variation of *Cymbella delicatula* and *C. hustedtii* from northern Lake Michigan. *Transactions of the American Microscopical Society* 97:311–319.

Kingston, J.C. 1980. Morphological observations of *Amphora thumensis* (Mayer) A.Cl. using light and scan-

ning electron microscopy. *Micron* 11:9–10.

KINGSTON, J.C. 1982. Association and distribution of common diatoms in surface samples from Northern Minnesota peatlands. *Nova Hedwigia Beihefte* 73:333–346.

KINGSTON, J.C. 2000. New combinations in the freshwater Fragilariaceae and Achnanthidiaceae. *Diatom Research* 15:407–409.

KINGSTON, J.C. 2004. Araphd and monoraphid diatoms. Pages 595–636 *in* J.D. Wehr and R.G. Sheath, eds., *Freshwater Algae of North America. Ecology and CLassification.* Academic Press, New York, USA. 918 pp.

KINGSTON, J.C., LOWE, R.L. AND STOERMER, E.F. 1979. Attached winter floral assemblages on sand from Grand Traverse Bay, Lake Michigan. *Micron* 10:203–204.

KINGSTON, J.C., LOWE, R.L., STOERMER, E.F. AND LADEWSKI, T.B. 1983. Spatial and temporal distribution of benthic diatoms in northern Lake Michigan. *Ecology* 64:1566–1580.

KINGSTON, J.C., LOWE, R.L. AND STOERMER, E.F. 1980. The frustular morphology of *Amphora thumensis* (Mayer) A. Cl. from northern Lake Michigan and consideration of its systematic position. *Transactions of the American Microscopical Society* 99:276–283.

KITTON, F. 1869. Notes on New York diatoms with description of a new species *Fragilaria crotonensis. Hardwicke's Science Gossip* 5:109–110.

KLARER, D.M. 1985. *An Annotated Species List of the Algae of Old Woman Creek Estuary.* Old Woman Creek Technical Report No. 3, Ohio Department of Natural Resources, Division of Natural Areas and U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Ocean and Coastal Resource Management, Sanctuary Programs Division. 48 pp.

KLARER, D.M. AND MILLIE, D.F. 1992. Aquatic macrophytes and algae at Old Woman Creek estuary and other Great Lakes coastal wetlands. *Journal of Great Lakes Research* 18:622–633.

KLARER, D.M. AND MILLIE, D.F. 1994. Regulation of phytoplankton dynamics in a Laurentian Great Lakes estuary. *Hydrobiologia* 286:97–108.

KLINE, P.A. AND LOWE, R.L. 1975. Phytoplankton of the Sandusky River near Fremont, Ohio. Pages 175–208 *in* D.B.Baker, W.B. Jackson, and B.L. Prater, eds., *Proceedings of Sandusky River Basin Symposium, May 2–3, 1975, Tiffin, Ohio.* International Reference Group on Great Lakes Pollution from Land Use Activities, International Joint Commission. 1976-653-346. 475 pp.

KLOTZ, R.L., CAIN, J.R. AND TRAINOR, F.R. 1976. Algal competition in an epilithic river flora. *Journal of Phycology* 12:363–368.

KOCIOLEK, J.P. AND HERBST, D.B. 1992. Taxonomy and distribution of benthic diatoms from Mono Lake, California. *Transactions of the American Microscopical Society* 111:338–356.

KOCIOLEK, J.P. AND KINGSTON, J.C. 1999. Taxonomy, ultrastructure and distribution of gomphonemoid diatoms (Bacillariophyceae: Gomphonemataceae) from rivers of the United States. *Canadian Journal of Botany* 77:686–705.

KOCIOLEK, J.P., LAMB, M.A. AND LOWE, R.L. 1983. Notes on the growth and ultrastructure of *Biddulphia laevis* Ehr. (Bacillariophyceae) in the Maumee River, Ohio. *Ohio Journal of Science* 83:125–130.

KOCIOLEK, J.P. AND LOWE, R.L. 1993. Taxonomy and ultrastructure of *Meridion lineare* D.M. Williams (Bacillariophyceae) from North America. *Nova Hedwigia* 57:381–391.

KOCIOLEK, J.P., MAHOOD, A.D. AND NUTILE, K. 1999. The types of the Diatom Collection of the California Academy of Sciences. Pages 157–196 *in* S. Mayama, K. Idea and I. Koizumi, eds., *Proceedings of the 14th International Diatom Symposium.* Koeltz Scientific Books, Koenigstein, Germany.

KOCIOLEK, J.P. AND ROSEN, B.H. 1984. Observations on North American *Gomphoneis* (Bacillariophyceae). I. Valve ultrastructure of *G. mammilla* with comment on the taxonomic status of the genus. *Journal of Phycology* 20:361–368.

KOCIOLEK, J.P. AND SPAULDING, S.A. 2004a. Symmetrical naviculoid diatoms. Pages 637–654 *in* J.D. Wehr and R.G. Sheath, eds., *Freshwater Algae of North America. Ecology and Classification.* Academic Press, New York, USA. 918 pp.

KOCIOLEK, J.P. AND SPAULDING, S.A. 2004b. Eunotioid and asymmetrical naviculoid diatoms. Pages 655–668 *in* J.D. Wehr and R.G. Sheath, eds., *Freshwater Algae of North America. Ecology and Classification.* Academic Press, New York, USA. 918 pp.

KOCIOLEK, J.P., SPAULDING, S.A. AND KINGSTON, J.C. 1998. Valve morphology and systematic position of *Navicula walkeri* (Bacillariophyceae), a diatom endemic to Oregon and California (USA) freshwaters. *Nova Hedwigia* 67:235–245.

KOCIOLEK, J.P. AND STOERMER, E.F. 1986. Observations on North American *Gomphoneis* (Bacillariophyceae). II. Descriptions and ultrastructure of two new species. *Transactions of the American Microscopical Society* 105:141–151.

KOCIOLEK, J.P. AND STOERMER, E.F. 1987. Ultrastructure of *Cymbella sinuata* (Bacillariophyceae) and its allies, and their transfer to *Reimeria*, gen. nov. *Systematic Botany* 12:451–459.

KOCIOLEK, J.P. AND STOERMER, E.F. 1987. Geographic range and variability of the diatom (Bacillariophyceae) *Gomphonema ventricosum* Gregory. *Nova Hedwigia* 45:223–236.

KOCIOLEK, J.P. AND STOERMER, E.F. 1988. Taxonomy, ultrastructure, and distribution of *Gomphoneis herculeana, G. eriense* and closely related species. *Proceedings of the Academy of Natural Sciences of Philadelphia* 140:24–97.

KOCIOLEK, J.P. AND STOERMER, E.F. 1990. A new, highly variable *Gomphonema* (Bacillariophyceae) species from the Laurentian Great Lakes. pp. 139–144 *in* M. Ricard, ed., *Ouvrage dédié à la Mémoire du Professeur Henri Germain (1903–1989).* O. Koeltz, Koenigstein, Germany.

KOCIOLEK, J.P. AND STOERMER, E.F. 1991. Taxonomy and ultrastructure of some *Gomphonema* Ehrenberg and *Gomphoneis* Cleve taxa from the upper Laurentian Great Lakes. *Canadian Journal of Botany* 69:1557–1576.

KOCIOLEK, J.P., STOERMER, E.F. AND BAHLS, L.L. 1986. Observations on North American *Gomphoneis* (Bacillariophyceae). III. *Gomphoneis septa* (Mogh.) comb. nov. *Canadian Journal of Botany* 64:2764–2768.

KOCIOLEK, J.P., STOERMER, E.F. AND EDLUND, M.A. 1995. Two New Freshwater Diatom Species. Pages 9–20 *in* J.P. Kociolek and M. Sullivan, eds., *A Century of Progress in Diatom Research in North America. A tribute to the Distinguished Careers of Charles W. Reimer and Ruth M. Patrick.* Koeltz Scientific Books, Champaign, Illinois, USA. 194 pp.

KOCH, A.R. 1975. Diatoms, including saltwater taxa, from southwestern Oklahoma. *Proceedings of the Oklahoma Academy of Science* 55:11–13.

KOCH, A.R. AND RISSER, P.G. 1974. Species composition and relative biomass of some algal communities growing on leaf detritus in a spring-fed stream. *Proceedings of the Oklahoma Academy of Science* 54:14–19.

KOFOID, C.A. 1900. The plankton of Echo River, Mammoth Cave. *Transactions of the American Microscopical Society* 21:113–126.

KOFOID, C.A. 1903. The plankton of the Illinois River, 1894–1899. Part I. Quantitative investigations and general results. *Bulletin of the Illinois State Laboratory for Natural History* 6:95–629.

KOFOID, C.A. 1908. The plankton of the Illinois River, 1894–1899. Part II. Constituent organisms and their seasonal distribution. *Bulletin of the Illinois State Laboratory for Natural History* 8:2–360.

KOOB, D.D. 1966. Parasitism of *Asterionella formosa* Hass. by a chytrid in two lakes of the Rawah Wild Area of Colorado. *Journal of Phycology* 2:41–44.

KOPCZYNSKA, E.E. 1980. Seasonal variations in phytoplankton in the Grand River mouth area of Lake Michigan. *Archive für Hydrobiologie* 27:95–123.

KOPPEN, J.D. 1975. A morphological and taxonomic consideration of *Tabellaria* (Bacillariophyceae) from the northcentral United States. *Journal of Phycology* 11:236–244.

KOPPEN, J.D. 1978. Distribution and aspects of the ecology of the genus *Tabellaria* Ehr. (Bacillariophyceae) in the northcentral United States. *American Midland Naturalist* 99:383–397.

KORTE, V.L. AND BLINN, D.W. 1983. Diatom colonization on artificial substrata in pool and riffle zones studied by light and scanning electron microscopy. *Journal of Phycology* 19:332–341.

KRAATZ, W.C. 1941. Quantitative plankton studies of Turkeyfoot Lake, near Akron, Ohio. *Ohio Journal of Science* 41:1–22.

KRAMMER, K. 1992. *Pinnularia.* Eine Monographie der europäischen Taxa. *Bibliotheca Diatomologica* 26:1–353.

KRAMMER, K. 1997a. Die cymbelloiden Diatomeen. Eine Monographie der weltweit bekannten Taxa. Teil 1.

Allgemeines und *Encyonema* Part. *Bibliotheca Diatomologica* 36:1–382.

Krammer, K. 1997b. Die cymbelloiden Diatomeen. Eine Monographie der weltweit bekannten Taxa. Teil 2. *Encyonema* Part., *Encyonopsis* und *Cymbellopsis*. *Bibliotheca Diatomologica* 37:1–469.

Krammer, K. 2000. The genus *Pinnularia*. In: H. Lange-Bertalot, ed., *Diatoms of Europe*, Vol. 1. A.R.G. Gantner Verlag, Ruggell, Germany. 703 pp.

Krammer, K. 2002. The genus *Cymbella*. In: H. Lange-Bertalot, ed., *Diatoms of Europe*, Vol. 3. A.R.G. Gantner Verlag, Ruggell, Germany. 584 pp.

Krammer, K. 2003. *Cymbopleura, Delicata, Navicymbula, Gomphocymbellopsis, Afrocymbella*. In: H. Lange-Bertalot, ed., *Diatoms of Europe*, Vol. 4. A.R.G. Gantner Verlag, Ruggell, Germany. 530 pp.

Krammer, K. and Lange-Bertalot, H. 1985. Naviculaceae. Neue und wenig Taxa, neue Kombinationen und Synonyme sowie Bemerkungen zu einigen Gattung. *Bibliotheca Diatomologica* 9:1–230.

Krammer, K. and Lange-Bertalot, H. 1986. Naviculaceae. In: H. Ettl, J. Gerloff, H. Heynig, D. Mollenhaer, eds., *Süßwasserflora von Mitteleuropa*, Vol. 2. Bacillariophyceae, Part 1. Gustav Fischer, Stuttgart, Germany. 876 pp.

Krammer, K. and Lange-Bertalot, H. 1988. Bacillariaceae, Epithemiaceae, Surirellaceae. In: H. Ettl, J. Gerloff, H. Heynig, D. Mollenhaer, eds., *Süßwasserflora von Mitteleuropa*, Vol. 2. Bacillariophyceae, Part 2. Gustav Fischer, Stuttgart, Germany. 596 pp.

Krammer, K. and Lange-Bertalot, H. 1991a. Centrales, Fragilariaceae, Eunotiaceae. H. Ettl, J. Gerloff, H. Heynig, D. Mollenhaer, eds., *Süßwasserflora von Mitteleuropa*, Vol. 2. Bacillariophyceae, Part 3. Gustav Fischer, Stuttgart, Germany. 576 pp.

Krammer, K. and Lange-Bertalot, H. 1991b. Achnanthaceae, Kritische Ergänzungen zu *Navicula* (Lineolatae) und *Gomphonema*. In: H. Ettl, J. Gerloff, H. Heynig, D. Mollenhaer, eds., *Süßwasserflora von Mitteleuropa*, Vol. 2. Bacillariophyceae, Part 4. Gustav Fischer, Stuttgart, Germany. 437 pp.

Kreis, R.G., Ladewski, T.B. and Stoermer, E.F. 1983. Influence of the St. Mary's River plume on northern Lake Huron phytoplankton assemblages. *Journal of Great Lakes Research* 9:40–51.

Kreis, R.G., Jr., and Stoermer, E.F. 1979. Diatoms of the Laurentian Great Lakes, III. Rare and poorly known species of *Achnantbes* Bory and *Cocconeis* Ehr (Bacillariophyta). *Journal of Great Lakes Research* 5:276–291.

Krejci, M.E. and Lowe, R.L. 1986. Importance of sand grain mineralogy and topography in determining micro-spatial distribution of epipsammic diatoms. *Journal of the North American Benthological Society* 5:211–220.

Krejci, M.E. and Lowe, R.L. 1987. Spatial and temporal variation of epipsammic diatoms in a spring-fed brook. *Journal of Phycology* 23:585–590.

Krejci, M.E. and Lowe, R.L. 1987. The seasonal occurrence of macroscopic colonies of *Meridion circulare* (Bacillariophyceae) in a spring-fed brook. *Transactions of the American Microscopical Society* 106:173–178.

Kutkuhn, J.H. 1958. The plankton of North Twin Lake, with particular reference to the summer of 1955. *Iowa State College Journal of Science* 32:419–450.

La Rivers, I. 1965. A preliminary listing of the algae of Nevada. *Biological Society of Nevada, Occasional Papers* 6:1–15.

Lackey, J.B. 1939. Aquatic life in waters polluted by acid mine waste. *Journal of the American Water Works Association* 31:740–747.

Lackey, J.B. 1942. The plankton algae and protozoa of two Tennessee rivers. *American Midland Naturalist* 27:191–202.

Lackey, J.B. 1943. Quality and quantity of plankton in the south end of lake Michigan in 1942. *Journal of the American Water Works Association* 36:669–674.

Lackey, J.B. and Hupp, E.R. 1956. Plankton populations in Indiana's White River. *Journal of the American Water Works Association* 49:1024–1036.

Ladewski, B.G., Kreis, Jr., R.G and Stoermer, E.F. 1982. *A Comparative Analysis of Lake Huron Phytoplankton Assemblages After Entrainment at Selected Water Intake Facilities*. University of Michigan, Great Lakes Research Division, Special Report No. 92. Ann Arbor, Michigan, USA. 128 pp.

Lamb, M.A. and Lowe, R.L. 1987. Effects of current velocity on the physical structuring of diatom

(Bacillariophyceae) communities. *Ohio Journal of Science* 87:72–87.

Lamberti, G.A. and Resh, V.A. 1983. Geothermal effects on stream benthos: separate influences of thermal and chemical components on periphyton and macroinvertebrates. *Canadian Journal of Fisheries and Aquatic Sciences* 40:1995–2009.

Lambou, V.W., Morris, F.A., Morris, M.K., Taylor, W.D., Williams, L.R. and Hern, S.C. 1978. *Phytoplankton Water Quality Relationships in U.S. Lakes, Part IV*: Genera *Hantzschia* through *Pteromonas* collected from eastern and southeastern lakes. National Eutrophication Survey Working paper No. 708. US E.P.A., Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. 104 pp.

Lambou, V.W., Morris, F.A., Thomas, R.W., Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A., Hern, S.C. and Hilgert, J.W. 1977. *Distribution of Phytoplankton in Maryland Lakes.* U.S. EPA-600/3-77-124, Ecological Research Series. 24 pp.

Lambou, V.W., Morris, F.A., Thomas, R.W., Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A., Hern, S.C. and Hilgert, J.W. 1977. *Distribution of Phytoplankton in West Virginia Lakes.* U.S. EPA-600/3-77-103, Ecological Research Series. 21 pp.

Lampkin, A.J. III and Sommerfeld, M.R. 1982. Algal distribution in a small, intermittent stream receiving acid mine-drainage. *Journal of Phycology* 18:196–199.

Lange, T.R. and Rada, R.G. 1993. Community dynamics in a typical navigation pool in the upper Mississippi River. *Journal of the Iowa Acdemy of Science* 100:21–27.

Lange-Bertalot, H. 1993. 85 Neue Taxa und über 100 weitere neu definierte Taxa ergänzend zur Süßwasserflora von Mitteleuropa Vol. 2/1–4. *Bibliotheca Diatomologica* 27:1–454.

Lange-Bertalot, H. 2001. *Navicula sensu stricto*, 10 genera separated from *Navicula sensu stricto, Frustulia*. In: H. Lange-Bertalot, ed., *Diatoms of Europe*, Vol. 2. A.R.G. Gantner Verlag, Ruggell, Germany. 526 pp.

Lange-Bertalot, H. and Metzeltin, D. 1996. *Ecology-Diversity-Taxonomy. Indicators of Oligotrophy. Iconographia Diatomologica*, Vol. 2. Koeltz Scientific Books, Koenigstein, Germany. 390 pp.

Lange-Bertalot, H., Metzeltin, D. and Witkowski, A. 1996. *Hippodonta* gen. nov. Umschreibung und Begründung einer neuen Gattung der Naviculaceae. *Iconographia Diatomologica* 4:247–266.

Lange-Bertalot, H. and Moser, G. 1994. *Brachysira.* Monographie der Gattung. *Bibliotheca Diatomologica* 29:1–212.

Larentyev, P.J., Gardner, W.S., Cavaletto, J.F. and Beaver, J.R. 1995. Effect of the zebra mussel (*Dreissena polymorpha* Pallas) on protozoa and phytoplankton from Saginaw Bay, Lake Huron. *Journal of Great Lakes Reserach* 21:545–557.

Larson, D.W., Dahm, C.N. and Geiger, N.S. 1987. Vertical partitioning of the phytoplankton assemblage in ultraoligotrophic Crater Lake, Oregon, USA. *Freshwater Biology* 18:429–442

Lawson, L.L. and Rushforth, S.R. 1975. The diatom flora of the Provo River Utah, U.S.A. *Bibliotheca Phycologia* 17:1–149.

Leake, D.V. 1945. The algae of Crystal Lake, Cleveland County, Oklahoma. *American Midland Naturalist* 34:750–768.

Leake, D.V. and Leake, H. 1962. Algae of Ozarkian springs and spring streams: winter aspect near head of Crane Creek, Stone County, Missouri. *Proceedings of the Oklahoma Academy of Science* 42:39–46.

Leland, H.V. 1995. Distribution of phytobenthos in the Yakima River basin, Washington, in relation to geology, land use, and other environmental factors. *Canadian Journal of Fisheries and Aquatic Sciences* 52:1108–1129.

Leland, H.V., Brown, L.R. and Mueller, D.K. 2001. Distribution of algae in the San Joaquin River, California, in relation to nutrient supply, salinity and other environmental factors. *Freshwater Biology* 46:1139–1167.

Leland, H.V. and Carter, J.L. 1984. Effects of copper on species composition of periphyton in a Sierra Nevada, California, stream. *Freshwater Biology* 14:281–296.

Leland, H.H. and Porter, S.D. 2000. Distribution of benthic algae in the upper Illinois River basin in relation to geology and land use. *Freshwater Biology* 44:279–301.

Lesht, B. M. and Rockwell, D.C. 1985. *The State of the Middle Great Lakes: Results of the 1983 Water*

Quality Survey of Lakes Erie, Huron, and Michigan. Report ANL/ER-85-2, Argonne National Laboratory, Argonne, Illinois, USA. 118 pp. + 3 app.

LEVANDOWSKY, M. 1972. An ordination of phytoplankton in ponds of varying salinity and temperature. *Ecology* 53:398–407.

LEWIS, F.W. 1861. Notes on new and rarer species of Diatomaceae of the United States seaboard. *Proceedings of the Academy of Natural Sciences of Philadelphia* 13:61–71.

LEWIS, F.W. 1863. On some new and singular intermediate forms of Diatomaceae. *Proceedings of the Academy of Natural Sciences of Philadelphia* 15:336–346.

LEWIS, F.W. 1865. On extreme and exceptional variation of diatoms, in some White Mountain localities, &c. *Proceedings of the Academy of Natural Sciences of Philadelphia* 1:7–18.

LEWIS, W.J. 1883. Microscopical examination of potable waters in the State of Connecticut. Pages 215–232 in *5th Annual Report of the Connecticut State Board of Health for 1882*.

LIPSCOMB, R.G. 1955. Botanical and chemical characteristics during the Fall overturn of a small eutrophic lake, Pretty Lake, Indiana. *United States Geological Survey Professional Paper* 550B:B204–B208.

LIPSCOMB, R.G. 1966. The winter phytoplankton and physical and chemical characteristics of Pretty Lake, Indiana. *United States Geological Survey Professional Paper* 550D:D242–D249.

LIPSEY, L.L. 1987. Freshwater diatoms (Bacillariophyceae) from the Northeastern Glacial Lake District of Wisconsin; I – *Attheya, Cyclotella, Melosira, Rhizosolenia*, and *Stephanodiscus* (order Centrales). *Rhodora* 87:261–278.

LIPSEY, L.L. 1988. Preliminary results of a classification of fifty-one selected northeastern Wisconsin lakes (USA) using indicator diatom species. *Hydrobiologia* 166:205–216.

LILLICK, L.C. AND LEE, I.M. 1934. A check-list of Ohio algae with additions from the Cincinnati region. *American Midland Naturalist* 15:713–751.

LIN, S., EVANS, R.L. AND BEUSCHER, D.B. 1973. Algae in the Spoon River, Illinois, 1971–1972. *Water Resources Bulletin* 9:1112–1124.

LOESCHER, J.H. 1981. Diatoms (Bacillariophyceae) from Sheeder Prairie, Guthrie County, Iowa. *Proceedings of the Iowa Academy of Science* 88:63–69.

LORENZ, B.D. 1973. Water quality, nutrients and net palnkton analysis of Summersville Lake. *Proceedings of the West Virginia Academy of Science* 45:146–154.

LORIFICE, G.J., AND MUNAWAR, M. 1974. The abundance of diatoms in the southwestern nearshore region of Lake Ontario during the spring thermal bar period. Pages 619–628 in *Proceedings of the 17th Conference on Great Lakes Research, McMasters University, Hamilton, Ontario, Canada, August 12–14, 1974*. International Association for Great Lakes Research, Ann Arbor, Michigan, USA.

LOWE, R.L. 1972. Diatom population dynamics in a central Iowa drainage ditch. *Iowa State Journal of Research* 47:7–59.

LOWE, R.L. 1972–1973. Notes on Iowa diatoms X: New and rare diatoms from Iowa. *Proceedings of the Iowa Academy of Science* 79:66–69.

LOWE, R.L. 1974. *Environmental Requirements and Pollution Tolerances of Freshwater Diatoms*. U.S. EPA-670/4–74–005, Cincinnati, Ohio, USA. 344 pp.

LOWE, R.L. 1975. Comparative ultrastructure of the valves of some *Cyclotella* species (Bacillariophyta). *Journal of Phycology* 11:415–424.

LOWE, R.L. 1976. *Phytoplankton in Michigan Nearshore Waters of Lakes Huron and Superior 1974*. Technical Report, Michigan Department of Natural Resources, Lansing, Michigan, USA. 30 pp.

LOWE, RL. 1979. Phytobenthic ecology and regulated streams. Pages 25–34 *in* J.V. Ward and J.A. Stanford, eds., *The Ecology of Regulated Streams*. Plenum Publishing Corporation, New York, New York, USA.

LOWE, R.L. 1981. The frustular morphology and distribution of *Cyclotella gamma* Sov. (Bacillariophyta). *Proceedings of the Iowa Academy of Science* 88:82–84.

LOWE, R.L. 2004. Keeled and canalled raphid diatoms. Pages 669–684 *in* J.D. Wehr and R.G. Sheath, eds., *Freshwater Algae of North America. Ecology and Classification*. Academic Press, New York, USA. 918 pp.

LOWE, R.L. AND BUSCH D.E. 1975. Morphological observations on two species of the diatom genus *Thalassiosira* from fresh-water habitats in Ohio. *Transactions of the American Microsopical Society*

94(1):118–123.

Lowe, R.L. and Collins, G.B. 1973. An aerophilous diatom community from Hocking County, Ohio. *Transactions of the American Microsopical Society* 92:492–496.

Lowe, R.L. and Crang, R.E. 1972. The ultrastructure and morphological variability of the frustule of *Stephanodiscus invisitatus* Hohn and Hellerman. *Journal of Phycology* 8:256–259.

Lowe, R.L. and Gale, W.F. 1980. Monitoring river periphyton with artificial benthic substrates. *Hydrobiologia* 69:235–244.

Lowe, R.L., Golladay, S.W. and Webster, J.R. 1986. Periphyton response to nutrient manipulation in streams draining clearcut and forested watersheds. *Journal of the North American Benthological Society* 5:221–229.

Lowe, R.L. and Kline, P.A. 1975. Planktonic centric diatoms from the Sandusky River, Ohio. Pages 143–152 *in* D.B. Baker, W.B. Jackson, and B.L. Prater, eds., *Proceedings of Sandusky River Basin Symposium, May 2–3, 1975, Tiffin, Ohio*. International Reference Group on Great Lakes Pollution from Land Use Activities, International Joint Commission. 1976-653-346. 475 pp.

Lowe, R.L. and Kociolek, J.P. 1984. New and rare diatoms from Great Smoky Mountains National Park. *Nova Hedwigia* 39:465–476.

Lowe, R.L. and McCullough, J.M. 1974. The effects of sewage-treatment plant effluent on diatom communites in the North Branch of the Portage River, Wood County, Ohio. *Ohio Journal of Science* 74:154–161.

Lowe, R.L., Rosen, B.H. and Kingston, J.C. 1982. A comparison of epiphytes on *Bangia atropurpurea* (Rhodophyta) and *Cladopbora glomerata* (Chlorophyta) from northern Lake Michigan. *Journal of Great Lakes Research* 8:164–168.

Luttenton, M.R. and Rada, R.G. 1986. Effects of disturbance on epiphytic community structure. *Journal of Phycology* 22:320–326.

Mahoney, R.K. and Reimer, C.W. 1987. Current status of the type collection (Bacillariophyceae) in the diatom herbarium, The Academy of Natural Sciences of Philadelphia. *Proceedings of the Academy of Natural Sciences of Philadelphia* 139:261–305.

Mahood A. 1978. The Harry E. Sovereign collection of northwest Pacific diatoms. *Proceedings of the California Academy of Sciences*, ser. 4, 41:339–343.

Mahood, A.D., Thomson, R.D. and Goldman, C.R. 1984. Centric diatoms of Lake Tahoe. *Great Basin Naturalist* 44:83–98.

Main, S.P. 1977. Benthic diatom colonization distribution in the Cedar River Basin, Iowa. *Proceedings of the Iowa Academy of Science* 84:23–29.

Main, S.P. 1988. Seasonal composition of benthic diatom associations in the Cedar River basin (Iowa). *Journal of the Iowa Academy of Science* 95:85–105.

Main, S.P. and Busch, D.E. 1992. Diatoms of northeastern Iowa fens. *Journal of the Iowa Academy of Science* 99:15–22.

Makarewicz, J.C. 1987. *Phytoplankton and Zooplankton Composition, Abundance and Distribution: Lake Erie, Lake Huron and Lake Michigan – 1983*. U.S. Environmental Protection Agency Report. U.S. EPA-905/2-87-002. 264 pp.

Makarewicz, J.C. 1987. Phytoplankton composition, abundance, and distribution: nearshore Lake Ontario and Oswego River and harbor. *Journal of Great Lakes Research* 13:56–64.

Makarewicz, J.C. 1988. *Phytoplankton and Zooplankton in Lakes Erie, Huron and Michigan: 1984*. U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL. U.S. EPA-905/3-88-001. 275 pp.

Makarewitcz, J.C. 1991. Feasibility of shoreside monitoring of the Great Lakes. *Journal of Great Lakes Research* 17:344–360.

Makarewicz, J.C. 1993. Phytoplankton biomass and species composition in Lake Erie, 1970 to 1987. *Journal of Great Lakes Research* 19:258–274.

Makarewicz, J.C. and Baybutt, R.I. 1981. Long-term (1927–1978) changes in the phytoplankton community of Lake Michigan at Chicago. *Bulletin of the Torrey Botanical Club* 108(2):240–254.

Makarewicz, J.C., Baybutt, R.I. and Damman, K. 1979. Changes in the apparent temperature optima of the plankton of Lake Michigan at Chicago, Illinois. *Journal of the Fisheries Research Board of Canada*

36:1169–1173.

MAKAREWICZ, J.C. AND BERTRAM, P. 1991. A lakewide comparison study of phytoplankton biomass and its species composition in Lake Huron, 1971 to 1985. *Journal of Great Lakes Research* 17:553–564.

MANOYLOV, K.M., MORALES, E. AND STOERMER, E.F. 2003. *Staurosira stevensonii* sp. nov. (Bacillariophyta), a new taxon from Florida, USA. European. *Journal of Phycology* 38:65–71.

MARCUS, M.D. 1980. Periphyton community response to chronic nutrient enrichment by a reservoir discharge. *Ecology* 61:387–399.

MARSHALL, H.G. 1976. The phytoplankton of Lake Drummond, Dismal Swamp, Virginia. *Castanea* 41:1–9.

MARSHALL, H.G. AND POORE, W.H. 1972. Phytoplankton composition at Lake Drummond in the Dismal Swamp, Va. Summer 1970. *Castanea* 37:59–69.

MCCORMICK, P.V., RAWLIK, P.S., LURDING, K., SMITH, E.P. AND SKLAR, F.H. 1996. Periphyton-water quality relationships along a nutrient gradient in the northern Everglades. *Journal of the North American Benthological Society* 15:433–449.

MCCORMICK, P.V. AND STEVENSON, R.J. 1989. Effects of snail grazing on benthic algal community structure in different nutrient environments. *Journal of the North American Benthological Society* 8:162–172.

MCCORMICK, P.V. AND STEVENSON, R.J. 1998. Periphyton as a tool for ecological assessment and management in the Florida Everglades. *Journal of Phycology* 34:726–733.

MCFARLAND, H.J. BRAZDA, E.A. AND MCFARLAND, B.H. 1964. A preliminary survey of the algae of Cheyenne Bottoms in Kansas. *Fort Hays Studies-New Series, Science Series* 2:1–80.

MCGAHA, Y.J. AND STEEN, J.P. 1974. *The Effects of Variation in Turbidity on Cycles of Planktonic and Benthic Organisms in Flood Control Reservoirs of Northern Mississippi.* Water Resources Research Institute, Mississippi State Univeristy, Mississippi State, Mississippi, USA. 29 pp.

MEDBURY, H.C. 1942. Limnological observations on San Francisco reservoirs. *Journal of the American Water Works Association* 34:719–728.

MEYER, R.L. 1971. A study of phytoplankton dynamics in Lake Fayetteville as a means of assessing water quality. *Arkansas Water Resources Research Center Publication* 10:1–59.

MICHALSKI, M.F.P. 1969. Planktonic and periphytic algae of the Great Lakes-A list of recorded species and their distribution. Pages 40–66 *in* D.V. Anderson, ed., *The Great Lakes as an Environment.* Great Lakes Institute, University of Toronto, Toronto, Canada.

MILLIE, D.F. AND LOWE, R.L. 1981. Diatoms new to Ohio and the Laurentian Great Lakes. *Ohio Journal of Science* 81:195–205.

MILLIE, D.F. AND LOWE, R.L. 1983. Studies on Lake Erie's littoral algae; Host specificity and temporal periodicity of epiphytic diatoms. *Hydrobiologia* 99:7–18.

MILLS, E.L., LEACH, J.H., CARLTON, J.T. AND SECOR, C.L. 1993. Exotic species in the Great Lakes: A history of biotic crises and anthropogenic introductions. *Journal of Great Lakes Research* 19:1–54.

MILLS, H. 1882. Microscopic organisms in the Buffalo water-supply and in Niagara River. *Proceedings of the American Society of Microscopists* 5:165–175.

MINCKLEY, W.L. AND TINDALL, D.R. 1965. Limnological observations on Doe Valley Lake, Meade County, Kentucky, during impoundment. *American Midland Naturalist* 73:248–250.

MOGHADAM, F. 1969. An ecological and systematic study of the planktonic diatom communities in Flathead Lake, Montana. *Proceedings of the Academy of Natural Sciences of Philadelphia* 121:153–228

MORALES, E.A. 2001. Morphological studies in selected fragilarioid diatoms (Bacillariophyceae) from Connecticut waters (U.S.A.). *Proceedings of the Academy of Natural Sciences of Philadelphia* 151:105–120.

MORALES, E.A. 2002. Studies in selected fragilarioid diatoms of petential indicator value from Florida (USA) with notes on the genus *Opephora* Petit (Bacillariophyeae). *Limnologica* 32:102–113.

MORALES, E.A. 2003. *Fragilaria pennsylvanica*, a new diatom (Bacillariophyceae) species from North America, with comments on the taxonomy of the genus *Synedra* Ehrenberg. *Proceedings of the Academy of Natural Sciences of Philadelphia* 153:155–166.

MORALES, E.A. 2003. On the taxonomic status of the genera *Belonastrum* and *Synedrella* proposed by Round and Maidana (2001). *Cryptogamie:Algologie* 24:277–288.

MORALES, E.A., BAHLS, L.L. AND CODY, W.R. 2005. Morphological studies of *Distrionella incognita* (Reichardt) Williams (Bacillariophyceae) from North America with comments on the taxonomy of

Distrionella Williams. *Diatom Research* 20:115–135.

Morris, F.A., Thomas, R.W., Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A., Hern, S.C. Hilgert, J.W. and Lambou, V.W. 1977. *Distribution of Phytoplankton in Indiana Lakes*. U.S. EPA National Eutrophication Survey Working Paper 682. 73 pp.

Morris, F.A., Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A., Hern, S.C. Hilgert, J.W. and Lambou, V.W. 1978. *Distribution of Phytoplankton in Georgia Lakes*. U.S. EPA-600/3-78-011, Ecological Research Series. 63 pp.

Morris, M.K., Taylor, W.D., Williams, L.R. Hern, S.C., Lambou, V.W. and Morris, F.A. 1978. *Phytoplankton Water Quality Relationships in U.S. Lakes, Part V*: Genera *Quadrigula* through *Zygnema* collected from eastern and southeastern lakes. National Eutrophication Survey Working Paper No. 709. US E.P.A., Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. 95 pp.

Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A., Hern, S.C. Hilgert, J.W., Lambou, V.W., Morris, F.A. and Thomas, R.W. 1977. *Distribution of Phytoplankton in Illinois Lakes*. U.S. EPA National Eutrophication Survey Working Paper 681. 131 pp.

Morris, M.K., Williams, L.R., Taylor, W.D., Hiatt, F.A., Hern, S.C. Hilgert, J.W., Lambou, V.W., Morris, F.A. and Thomas, R.W. 1977. *Distribution of Phytoplankton in North Carolina Lakes*. U.S. EPA National Eutrophication Survey Working paper 687. 75 pp.

Morris, F.A., Morris, M.K., Taylor, W.D., Williams, L.R., Hern, S.C. and Lambou, V.W. 1979. *Distribution of Phytoplankton in Nebraska Lakes*. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. Report No. EPA 600/3-79-066. 32 pp.

Morris, M.K., Taylor, W.D., Williams, L.R., Hern, S.C., Lambou, V.W. and Morris, F.A. 1979a. *Distribution of Phytoplankton in Missouri Lakes*. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. Report No. EPA 600/3-79-065. 29 pp.

Morris, M.K., Taylor, W.D., Williams, L.R., Hern, S.C., Lambou, V.W. and Morris, F.A. 1979b. *Distribution of Phytoplankton in Colorado Lakes*. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. Report No. EPA 600/3-79-114. 40 pp.

Morrissey, B.S. 1929. Survey of algae in ponds on Presque Ilse, Erie, Pa., Summer, 1928. *Proceedings of the Pennsylvania Academy of Science* 3:47–51.

Morrow, A.C., Deason, T.R. and Clayton, D. 1981. A new species of the diatom genus *Eunotia*. *Journal of Phycology* 17:265–270.

Moss, B. 1972. Studies on Gull Lake, Michigan. I. Seasonal and depth distribution of phytoplankton. *Freshwater Biology* 2:289–307.

Mou-Sheng, C. and Rushforth, S.R. 1977. The algal flora of the campus of Brigham Young University, Provo, Utah. *Great Basin Naturalist* 37:402–406.

Muenscher, W.C. 1928. Plankton studies of Cayuga, Seneca and Oneida Lakes. *New York State Conservation Department, Annual Report*, Supplement 17:140–157.

Mulholland, P.J., Elwood, J.W., Palumbo, A.V. and Stevenson, R.J. 1986. Effect of stream acidification on periphyton composition, chlorophyll and productivity. *Canadian Journal of Fisheries and Aquatic Sciences* 43:1846–1858.

Munawar, M. and Munawar, I.F. 1976. A lakewide study of phytoplankton biomass and its species composition in Lake Erie, April–December, 1970. *Journal of the Fisheries Research Board of Canada* 33:581–600.

Munawar, M. and Munawar, I.F. 1978. Phytoplankton of Lake Superior 1973. *Journal of Great Lakes Research* 4:415–442.

Munawar, M. and Munawar, I.F. 1979. *A Preliminary Account of Lake Huron Pytoplankton, April–December 1971*. Canada Centre for Inland Waters, Fisheries and Marine Service Technical Report No. 917. Burlington, Ontario, Canada. 15 pp.

Munawar, M. and Munawar, I.F. 1981. A general comparison of the taxonomic composition and size analysis of the phytoplankton of the North American Great Lakes. *Verhandlungen Internationale Verein Limnologie* 21:1695–1716.

Munawar, M. and Munawar, I.F. 1982. Phycological studies on lakes Ontario, Erie, Huron, and Superior. *Canadian Journal of Botany* 60:1873–1858.

Munawar, M. and Nauwerck, A. 1971. The composition and horizontal distribution of phytoplankton in Lake Ontario during the year 1970. Pages 69–78 in *Proceedings of the 14th Conference on Great Lakes Research*. International Association for Great Lakes Research, Ann Arbor, Michigan, USA.

Munawar, M., Munawar, I.F., Culp, L.R. and Dupuis, G. 1978. Relative importance of nannoplankton in Lake Superior phytoplankton biomass and community metabolism. *Journal of Great Lakes Research* 4:462–480.

Myers, P.C. 1898. Preliminary report on the diatoms of Iowa. *Proceedings of the Iowa Academy of Science* 6:47–52.

Nagy, J.P. 1965. Preliminary report of the algae of Crystal Cave, Kentucky. *International Journal of Speology* 1:479–490.

Nalewajko, C. 1966. Composition of phytoplankton in surface waters of Lake Ontario. *Journal of the Fisheries Board of Canada* 23:1715–1725.

Nalewajko, C. 1967. Phytoplankton distribution in Lake Ontario. Pages 63–69 in *Proceedings of the 10th Conference on Great Lakes Research*. International Association for Great Lakes Research, Ann Arbor, Michigan, USA.

Neel, J.K. 1968. Seasonal succession of benthic algae and their macroinvertebrate residents in a head-water limestone stream. *Journal of Water Pollution Control Federation* 40:R10–R30.

Ngo, H., Prescott, G. and Czarnecki, D. 1987. Additions and confirmations to the algal flora of Itasca State Park—I—Desmids and diatoms from North Deming Pond. *Journal of the Minnesota Academy of Science* 52:14–17.

Odlaug, T.O. and Olsen, T.A. 1969. The ecology of periphyton in Western Lake Superior. Part 1. Taxonomy and distribution. *Water Resources Research Center, University of Minnesota Bulletin* 14:1–127.

Oemke, M.P. and Burton, T.M. 1986. Diatom colonization dynamics in a lotic system. *Hydrobiologia* 139:153–166.

Ogawa, R.E. 1969. Lake Ontario phytoplankton, September, 1964. Pages 27–28 in *Limnological Survey of Lake Ontario, 1964*. Great Lakes Fishery Commission Technical Report No. 14. Ann Arbor, Michigan, USA.

Olive, J.H. 1968. Primary productivity-phytoplankton relationships, Hodgson Lake, Portage County, Ohio. *Ohio Journal of Science* 68:152–160.

Olive, J.H., Benton, D.M. and Kishler, J. 1969. Distribution of C^{14} in products of phytosynthesis and its relationship to phytoplankton composition and rate of photosynthesis. *Ecology* 50:380–386.

Olive, J.H. and Price, J.L. 1978. Diatom assemblages of the Cuyahoga River, N.E. Ohio (USA). *Hydrobiologia* 57:175–187.

Olsen, R. and Sommerfield, M. 1970. A preliminary study of planktonic diatoms of central Arizona. *Journal of the Arizona Academy of Science* 6:135–138.

O'Quinn, R.D. and Sullivan, M.J. 1983. Community structure dynamics of epilithic and epiphytic diatoms in a Mississippi stream. *Journal of Phycology* 19:123–128.

Orser, J.A. and Dillard, G.E. 1980. Analysis of the periphyton of Sloan's Crossing Pond, Mammoth Cave National Park, Kentucky. *Transactions of the Kentucky Academy of Science* 41:60–69.

Palmer, C.M. 1931. Algae of Indiana: additions to the 1875–1928 check list. *Proceedings of the Indiana Academy of Science* 40:107–109.

Palmer, C.M. 1958. Algae and other organisms in water of the Chesapeake area. *Journal of the American Water Works Association* 50:938–950.

Palmer, C.M. 1959. *Algae in Water Supplies. An Illustrated Manual on the Identification, Significance, and Control of Algae in Water Supplies*. U.S. Department of Health, Education, and Welfare, Public Health Service, Taft Sanitary Engineering Center, Cincinnati, Ohio, USA. 88 pp.

Palmer, C.M. 1960. Algae and other interference organisms in the waters of the South Central United States. *Journal of the American Water Works Association* 52:897–913.

Palmer, C.M. 1961. Algae and other interference organisms in water supplies in California. *Journal of the American Water Works Association* 53:1297–1312.

Palmer, C.M. 1967. Algae in relation to water quality in Pennsylvania. *Proceedings of the Pennsylvania Academy of Science* 41:1–12.

PALMER, C.M. 1969. A composite rating of algae tolerating organic pollution. *Journal of Phycology* 5:78–82.

PALMER, C.M. 1975. Algae. Pp 15–41 *in* F.K. Parrich, ed., *Keys to Water Quality Indicative Organisms of the Southeastern United States*. U.S. Environmental Protection Agency, Cincinnati, Ohio, USA. 195 pp.

PALMER, C.M. AND POSTON, H. 1956. Algae and other interference organisms in Indiana water supplies. *Journal of the American Water Works Association* 48:1335–1346.

PAMPERL, M.A. 1980. Diatoms of Lake of the Ozarks, Missouri. *Transactions of the Missouri Academy of Science* 14:85–92.

PAN, Y. AND STEVENSON, R.J. 1996. Gradient analysis of diatom assemblages in western Kentucky wetlands. *Journal of Phycology* 32:222–232.

PAN, Y., STEVENSON, R.J., HILL, H.B. AND HERLIHY, A.T. 2000. Ecoregions and benthic diatom assemblages in Mid-Atlantic Highlands streams, USA. *Journal of the North American Benthological Society* 19:518–540.

PAN, Y, STEVENSON, R.J., HILL, B.H., HERLIHY, A.T. AND COLLINS, G.D. 1996. Using diatoms as indicators of ecological conditions in lotic systems: a regional assessment. *Journal of the North American Benthological Society* 15:481–495.

PAN, Y., STEVENSON, R.J., HILL, B.H., KAUFMAN, P.R. AND HERLIHY, A.T. 1999. Spatial patterns and ecological determinations of benthic algal assemblages in mid-Atlantic streams, USA. *Journal of Phycology* 35:460–468.

PASSY, S.I. 2001. Spatial paradigms of lotic diatom distribution: a landscape ecology perspective. *Journal of Phycology* 37:370–378.

PATRICK, R.M. 1936. Some diatoms of Great Salt Lake. *Bulletin of the Torrey Botanical Club* 63:157–166.

PATRICK, R.M. 1939. Nomenclatural changes in two genera of diatoms. *Notulae Naturae* 28:1–11.

PATRICK, R.M. 1943. The diatoms of Linsely Pond, Connecticut. *Proceedings of the Academy of Natural Sciences of Philadelphia* 95:53–110.

PATRICK, R.M. 1945. A taxonomic and ecological study of some diatoms from the Pocono Plateau and adjacent regions. *Farlowia* 2:143221.

PATRICK, R.M. 1946. Diatoms from Patschke Bog, Texas. *Notulae Naturae* 170:1–7.

PATRICK, R.M. 1948. Factors affecting the distribution of diatoms. *Botanical Review* 14:473–517.

PATRICK, R.M. 1949. A proposed biological measure of stream conditions based on a survey of the Conestoga Basin, Lancaster County, Pa. *Proceedings of the Academy of Natural Sciences of Philadelphia* 101:277–341.

PATRICK, R.M. 1954. The diatom flora of Bethany Bog. *Journal of Protozoology* 1:34–37.

PATRICK, R.M. 1958. Some nomenclatural problems and a new species and a new variety in the genus *Eunotia* (Bacillariophyceae). *Notulae Naturae* 312:1–15.

PATRICK, R.M. 1959. New subgenera and two new species of the genus *Navicula* (Bacillariophyceae). *Notulae Naturae* 324:1–11.

PATRICK, R.M. 1959. New species and nomenclatural changes in the genus *Navicula* (Bacillariophyceae). *Proceedings of the Academy of Natural Sciences of Philadelphia* 101:91–108.

PATRICK, R.M. 1961. A study of the numbers and kinds of species found in the rivers in eastern United States. *Proceedings of the Academy of Natural Sciences of Philadelphia* 113:215–258.

PATRICK, R.M. 1963. The structure of diatom communities under varying ecological conditions. *Annals of the New York Academy of Sciences* 108:353–358.

PATRICK, R.M. 1964. A discussion of natural and abnormal diatom communities. Pages 185–204 *in* D.F. Jackson, ed., *Algae and Man*. Plenum Press, New York, New York, USA.

PATRICK, R.M. 1967. The effect of invasion rate, species pool, and size of area on the structure of the diatom community. *Proceedings of the National Academy of Sciences, USA* 58:1335–1342.

PATRICK, R.M. 1968. The structure of diatom communities in similar ecological conditions. *American Naturalist* 102:173–183.

PATRICK, R.M. 1971. The effects of increasing light and temperature on the structure of diatom communities. *Limnology and Oceanography* 16:405–421.

PATRICK, R.M. 1972. Benthic communities in streams. *Transactions of the Connecticut Academy of Arts and Sciences* 44:271–284.

PATRICK, R.M. 1976. The formation and maintenance of benthic diatom communities. *Proceedings of the*

American Philosophical Society 120:475–484.

Patrick, R.M., Cairns, Jr., J. and Roback, S.S. 1967. An ecosystematic study of the fauna and flora of the Savannah River. *Proceedings of the Academy of Natural Sciences of Philadelphia* 118:109–407.

Patrick, R.M., Cairns, Jr., J. and Scheier, A. 1968. The relative sensitivity of diatoms, snails and fish to twenty common constituents of industrial wastes. *The Progressive Fish Culturist* 30:137–140.

Patrick, R.M. Cocke, E.C. and Lewis, I.F. 1934. A further study of Dismal Swamp peat. *American Journal of Botany* 21:374–395.

Patrick, R.M., Crum, B. and Coles, J. 1969. Temperature and manganese as determining factors in the presence of diatom or blue-green algal floras in streams. *Proceedings of the National Academy of Sciences, USA* 64:472–478.

Patrick, R.M., Hohn, M.H. and Wallace, J.H. 1954. A new method for determining the pattern of the diatom flora. *Notulae Naturae* 259:1–12.

Patrick, R.M., Lewis, I.F. and Zirkle, C. 1933. Algae of Charlottesville and vicinity. *Journal of the Elisha Mitchell Scientific Society* 58:207–223.

Patrick, R.M. and Reimer, C.W. 1966. *The Diatoms of the United States*. Monograph 13. Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, USA. 688 pp.

Patrick, R.M. and Reimer, C.W. 1975. *The Diatoms of the United States*. Monograph 13, vol. 2, pt. 1. Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, USA. 213 pp.

Patrick, R.M. and Roberts, N.A. 1979. Diatom communities in the Middle Atlantic States. Some factors that are important to their structure. *Nova Hedwigia Beihefte* 54:265–283.

Patrick, R.M., Roberts, N.A. and Davis, B. 1968. The effect of changes in pH on the structure of diatom communities. *Notulae Naturae* 416:1–16.

Patrick, R.M. and Strawbridge, D. 1963. Variation in the structure of natural diatom communities. *American Naturalist* 97:51–57.

Pennak, R.W. 1949. Annual limnological cycles in some Colorado reservoir lakes. *Ecological Monographs* 19:233–267.

Peterson, B.J., Barlow, J.P. and Savage, A.E. 1974. The physiological state with respect to phosphorus of Cayuga Lake phytoplankton. *Limnology and Oceanography* 19:396–408.

Peterson, C.G. 1987. Gut passage and insect grazer selectivity of lotic diatoms. *Freshwater Biology* 18:455–460.

Peterson, C.G. 1987. Influences of flow regime on development and desiccation response of lotic diatom communities. *Ecology* 68:946–954.

Peterson, C.G. and Stevenson, R.J. 1989. Substratum conditioning and diatom colonization in different current regimes. *Journal of Phycology* 25:790–793.

Peterson, C.G. and Stevenson, R.J. 1989. Seasonality in river phytoplankton: multivariate analyses of data from the Ohio River and six Kentucky tributaries. *Hydrobiologia* 182:99–114.

Peterson, C.G. and Stevenson, R.J. 1990. Post-spate development of epilithic algal communities in different current environments. *Canadian Journal of Botany* 68:2092–2102.

Peterson, C.G. and Stevenson, R.J. 1992. Resistance and resilience of lotic algal communities: importance of disturbance timing and current. *Ecology* 73:1445–1461.

Pfiester, L.A., Lynch, R. and Wright, T.L. 1979. Species composition and diversity of periphyton in the Grand River Dam area, Mayes County, Oklahoma. *The Southwestern Naturalist* 24:149–164.

Pfiester, L.A. and Terry, S. 1978. Additions to the algae of Oklahoma. *The Southwestern Naturalist* 23:85–94.

Phillips, R.C. and Whitford, L.A. 1958. Additions to the fresh-water algae in North Carolina II. *Castanea* 23:25–30.

Pienkowski, T.P. and Wujek, D.E. 1987. The diatom flora of the Red Lake peatland, Minnesota. *Journal of the Minnesota Academy of Science* 53:7–13.

Potapova, M. and Charles, D.F. 2002. Benthic diatom in USA rivers: distributions along spatial and environmental gradients. *Journal of Biogeography* 29:167–187.

Potapova, M. and Charles, D.F. 2003. Distribution of benthic diatoms in U.S. rivers in relation to conductivity and ionic composition. *Freshwater Biology* 48:1311–1328.

POTAPOVA, M.G. AND PONADER, K.C. 2004. Two common North American diatoms, *Achnanthidium rivulare* sp. nov. and *A. deflexum* (Reimer) Kingston: morphology, ecology and comparison with related species. *Diatom Research* 19:33–57.

POTAPOVA, M.G., PONADER, K.C., LOWE, R.L., CLASON, T.A. AND BAHLS, L.L. 2003. Small-celled *Nupela* species from North America. *Diatom Research* 18:293–306.

POWER, M.E. AND STEWART, A.J. 1987. Disturbance and recovery of an algal assemblage following flooding in an Oklahoma stream. *American Midland Naturalist* 117:333–345.

POWERS, C.F. AND AYERS, J.C. 1967. Water quality and eutrophication trends in southern Lake Michigan, Pages 142–178 *in* J.C. Ayers and D.C. Chandler, eds., *Studies on the Environment and Eutrophication of Lake Michigan*. University of Michigan, Great Lakes Research Division, Special Report No. 30. Ann Arbor, Michigan, USA.

POWERS, R.E. 1969. *Phytoplankton Found in the Kansas River System*. U.S. Department of the Interior, Federal Water Pollution Control Administration, Missouri Basin Region, Kansas City, Missouri, USA. 11 pp.

PRESCOTT, G.W, DILLARD, G.E. 1979. A checklist of algal species reported from Montana 1891 to 1977. Monograph No. 1. *Proceedings of the Montana Academy of Sciences*, Supplement 36:1102.

PRINGLE, C.M. 1990. Nutrient spatial heterogeneity: effects on community structure, physiognomy, and diversity of stream algae. *Ecology*. 71:905–920.

PRINGLE, C.M. AND BOWERS, J.A. 1984. An *in situ* substratum fertilization technique: diatom colonization on nutrient-enriched, sand substrata. *Canadian Journal of Fisheries and Aquatic Science* 41:1247–1251.

PRINGLE, C.M., WHITE, D.S., RICE, C.P. AND TUCHMAN, M.L. 1981. *The Biological Effects of Chloride and Sulfate with Special Emphasis on the Laurentian Great Lakes*. University of Michigan, Great Lakes Research Division, Publication 20. Ann Arbor, Michigan, USA. 51 pp.

PRYFOGLE, P.A. AND LOWE, R.L. 1975. Seasonal distribution of periphytic diatom communities of Tymochtee Creek. Pages 153–173 *in* D.B. Baker, W.B. Jackson, and B.L. Prater, eds., *Proceedings of Sandusky River Basin Symposium, May 2–3, 1975, Tiffin, Ohio.* International Reference Group on Great Lakes Pollution from Land Use Activities, International Joint Commission. 1976-653-346. 475 pp.

PURDY, W.C. 1923. *A Study of the Pollution and Natural Purification of the Ohio River, I. The Plankton and Related Organisms*. Public Health Service Bulletin 131, U.S. Public Health Service. 77 pp.

RAFTER, G.W. 1888. On the micro-organisms of Hemlock lake water. *American Monthly Microscopical Journal* 9:87–92.

RASCHKE, R.L. 1993. Diatom (Bacillariophyta) community responses to phosphorus in the Everglades National Park, USA. *Phycologia* 32:48–58.

REED, E.B. AND OLIVE, J.R. 1956. Annual cycle of net plankton in a fluctuating north-central Colorado reservoir. *Ecology* 37:713–718.

REICHARDT, E. 1999. Zur Revision der Gattung *Gomphonema*. Die Arten um *G. affine/insigne, G. angustatum/ micropus, G. acuminatum* sowie gomphonemoide Diatomeen aus dem Oberoligozän in Böhmen. *Iconographia Diatomologica* 8:1–203.

REICHARDT, E. AND LANGE-BERTALOT, H. 1991. Taxonomische Revision des Artenkomplexes um *Gomphonema angustatum—G. dichotomum—G. intricatum—G. vibrio* und ähnlicher Taxa (Bacillariophyceae). *Nova Hedwigia Beihefte* 53:519–544.

REIF, C.B. 1939. The effect of stream conditions on lake plankton. *Transactions of the American Microscopical Society* 58:398–403.

REIMER, C.W. 1958. Re-evaluation of the diatom-species *Nitzschia frustulum* (Kütz.) Grun. *Butler University Botanical Studies* 11:178–191.

REIMER, C.W. 1959. The diatom genus *Neidium*. I. New species, new records and taxonomic revision. *Proceedings of the Academy of Natural Sciences of Philadelphia* 111:1–35.

REIMER, C.W. 1959. Some new United States distribution records for the diatom genus *Navicula* (Bacillariophyceae): ecological notes and comment. *Proceedings of the Academy of Natural Sciences of Philadelphia*. 111:77–89.

REIMER, C.W. 1961. New and variable taxa of the diatom genera *Anomoeoneis* Pfitz. and *Stauroneis* Ehr. (Bacillariophyta) from the United States. *Proceedings of the Academy of Natural Sciences of Philadelphia*

113:187–214.

Reimer, C.W. 1961. Some aspects of the diatom flora of Cabin Creek Raised Bog, Randolph Co., Indiana. *Proceedings of the Indiana Academy of Science* 71:305–319.

Reimer, C.W. 1966. Consideration of fifteen diatom taxa (Bacillariophyta) from the Savannah River, including seven described as new. *Notulae Naturae* 397:1–15.

Reimer, C.W. 1970. Some diatoms (Bacillariophyceae) from Cayler Prairie. *Nova Hedwigia* 31:235–249.

Reimer, C.W. 1982. Four unreported diatom (Bacillariophyceae) taxa from northwest Iowa. *Nova Hedwigia Beihefte* 73:267–273.

Reimer, C.W. 1990. Diatoms (Bacillariophyceae) from the Excelsior fen-complex, Dickinson Co., Iowa, with the description of two new taxa. *Journal of the Iowa Academy of Science* 97:146–152.

Reimer, C.W., Henderson, M.V. and Mahoney, R.K. 1991. Contributions of Charles S Boyer (1856–1928) to the knowledge of diatoms (Bacillariophyceae): biographical notes, literature and taxonomic summary, with type designations. *Proceedings of the Academy of Natural Sciences of Philadelphia* 143:161–172.

Reinhard, E.G. 1931. The plankton ecology of the upper Mississippi, Minneapolis to Winona. *Ecological Monographs* 1:395–464.

Reinke, D.C. 1979a. New and interesting algae from Kansas. *Reports of the State Biological Survey of Kansas* 23:1–70.

Reinke, D.C. 1979b. A preliminary checklist of Kansas algae. *Technical Publications of the State Biological Survey of Kansas* 8:67–71.

Reinke, D.C. 1981. New records and distributional notes of Kansas algae for 1980. *Technical Publications of the State Biological Survey of Kansas* 10:57–64.

Reinke, D.C. 1982a. Algae collected by Rufus H. Thompson, I: New records for Kansas. *Technical Publications of the State Biological Survey of Kansas* 12:21–38.

Reinke, D.C. 1982b. New records and distributional notes of Kansas algae for 1981. *Technical Publications of the State Biological Survey of Kansas* 12:61–69.

Reinke, D.C. 1984. Ultrastructure of *Chaetoceros muelleri* (Bacillariophyceae): auxospore, resting spore, and vegetative cell morphology. *Journal of Phycology* 20:153–155.

Reinke, D.C. 1985. First report of *Chaetoceros muelleri* Lemn. (Bacillariophyceae) from Kansas. *Transactions of the Kansas Academy of Science* 88:68–70.

Reinward, J.F. 1969. Planktonic diatoms of Lake Ontario. Pages 19–26 in *Limnological Survey of Lake Ontario, 1964*. Great Lakes Fishery Commission, Technical Report No. 14. Ann Arbor, Michigan, USA.

Reisen, W.K. and Spencer, D.J. 1970. Succession and current demand relationships of diatoms on artificial substrates in Praters Creek, South Carolina. *Journal of Phycology* 6:117–121.

Reuter, J.E. 1979. Seasonal distribution of phytoplankton biomass in a nearshore area of the central basin of Lake Erie, 1975–1976. *Ohio Journal of Science* 79:218–226.

Richman, S., Sager, P.E., Banta, G., Harvey, T.R. and Destasio, B.T. 1984. Phytoplankton standing stock, size distribution, species composition and productivity along a trophic gradient in Green Bay, Lake Michigan. *Verhandlungen Internationale Verein Limnologie* 22:460–469.

Riley, G.A. 1940. Limnological studies in Connecticut III. The plankton of Linsley Pond. *Ecological Monographs* 10:279–305.

Roach, L.S. 1932. An ecological study of the plankton of the Hocking River. *Bulletin of the Ohio Biological Survey* 5:253–279.

Roberts, D.A. and Boylen, C.W. 1988. Patterns of epipelic algal distribution in an acidic Adirondack lake. *Journal of Phycology* 24:146–152.

Robinson, C.T. 1987. Effects of physical disturbance and canopy cover on attached diatom community structure in an Idaho stream. *Hydrobiologia* 154:49–59.

Robinson, C.T., Rushforth, S.R. and Minshall, G.W. 1994. Diatom assemblages of streams influenced by wildfire. *Journal of Phycology* 30:209–216.

Robinson, D.G. 1974. *A Qualitative Survey of Periphytic Diatoms in the Vicinity of the Donald C. Cook Nuclear Power Plant*. Pages 179–200 *in* University of Michigan, Great Lakes Research Division Special Report 51. Ann Arbor, Michigan, USA.

Rockwell, D.C., Devault, D.S., Palmer, M.F., Marion, C.V. and Bowden, R.J. 1980. *Lake Michigan*

Intensive Survey 1976–1977. U.S. Environmental Protection Agency Report No. EPA-905/4-80-003-A.

ROEMER, S.C., HOAGLAND, K.D. AND ROSOWSKI, J.R. 1984. Development of a freshwater periphyton community as influenced by diatom mucilages. *Canadian Journal of Botany* 62:1799–1813.

ROEMER, S.C. AND ROSOWSKI, J.R. 1980. Valve and band morphology of some freshwater diatoms. III. Pre- and post-auxospore frustules and the initial cell of *Melosira roseana*. *Journal of Phycology* 16:399–411.

ROSEN, B.H. 1981. Observations of differential epiphytism on *Cladophora glomerata* and *Bangia atropurpurea* from Grand Traverse Bay, Lake Michigan. *Micron* 12:219–220.

ROSEN, B.H. AND LOWE, R.L. 1981. Valve ultrastructure of some confusing Fragilariaceae. *Micron* 12: 293–294

ROSS, L. AND RUSHFORTH, S.R. 1980. The effects of a new reservoir on the attached diatom communities in Huntington Creek, Utah, USA. *Hydrobiologia* 68:157–165.

ROSSMANN, R. 1986. *Southeastern Nearshore Lake Michigan: Impact of the Donald C. Cook Nuclear Plant*. University of Michigan, Great Lakes Research Division, Publication 22. Ann Arbor, Michigan, USA. 432 pp.

ROSSMANN, R., MILLER, N.M. AND ROBINSON, D.G. 1977. *Benton Harbor Power Plant Limnological Studies. Part XXIV. Entrainment of Phytoplankton at the Donald C. Cook Nuclear Plant – 1975*. University of Michigan, Great Lakes Research Division, Special Report 44. Ann Arbor, Michigan, USA. 265 pp.

ROSSMANN, R., CHANG, W., DAMASKE, L.D. AND YOCUM, W.L. 1980. *Entrainment of Phytoplankton at the Donald C. Cook Nuclear Plant – 1977*. University of Michigan, Great Lakes Research Division, Special Report 67. Ann Arbor, Michigan, USA. 180 pp.

ROSSMANN, R., CHANG, W. AND BARRES, J. 1982. *Benton Harbor Power Plant Limnological Studies. Part XXX. Entrainment of Phytoplankton at the Donald C. Cook Nuclear Plant – 1979*. University of Michigan, Great Lakes Research Division, Special Report 44. Ann Arbor, Michigan, USA. 98 pp.

RUCK, E.C. AND KOCIOLEK, J.P. 2004. Preliminary phylogeny of the Family Surirellaceae. *Bibliotheca Diatomologica* 50:1–236.

RUSHFORTH, S.R. AND BATEMAN, L. 1984. Diatom floras of selected Uinta Mountain lakes, Utah, U.S.A. *Bibliotheca Diatomologica* 4:1–99.

RUSHFORTH, S.R., BROTHERSON, J.D., FUNGLADDA N. AND EVENSON, W.E. 1981. The effects of dissolved heavy metals on attached diatoms in the Uintah Basin of Utah, USA. *Hydrobiologia* 83:313–323

RUSHFORTH, S.R. AND JOHANSEN, J.R. 1986. The inland *Chaetoceros* (Bacillariophyceac) species of North America. *Journal of Phycology* 22:441–448.

RUSHFORTH, S.R. AND MERKLEY, G.S. 1988. Comprehensive list by habitat of the algae of Utah, USA. *Great Basin Naturalist* 48:154–179.

RUSHFORTH, S.R. AND SQUIRES, L.E. 1985. New records and comprehensive list of the algal taxa of Utah Lake, Utah, USA. *Great Basin Naturalist* 45:237–254.

RUSHFORTH, S.R., SQUIRES, L.E. AND CUSHING, C.E. 1986. Algal communities of springs and streams in the Mt. St. Helens region, Washington, U.S.A. following the May 1980 eruption. *Journal of Phycology* 22:129–137.

RUSHFORTH, S.R., SQUIRES, L.E. AND JOHANSEN, J.R. 1986. Three new records for diatoms from the Great Basin, USA. *Great Basin Naturalist* 46:398–403.

RUSHFORTH, S.R., ST. CLAIR, L.L., GRIMES, J.A. AND WHITING, M.C. 1981. Phytoplankton of Utah Lake. *Great Basin Naturalist Memoirs* 5:85–100.

RUSHFORTH, S.R., ST. CLAIR, L.L., LESLIE, T.A., THORNE, K.H. AND ANDERSON, D.C. 1976. The algal flora of two hanging gardens in Southeastern Utah. *Nova Hedwigia* 27:231–323.

SABATER, S., GREGORY, S.V. AND SEDELL, J.R. 1998. Community dynamics and metabolism of benthic algae colonizing wood and rock substrata in a forest stream. *Journal of Phycology* 34:561–567.

SAMSEL, G.L., JR. 1973. Effects of sedimentation on the algal flora of a small recreational impoundment. *Water Resurces Bulletin* 9:1145–1152.

SANDUSKY, J.C. AND HORNE, A.J. 1978. A pattern analysis of Clear Lake phytoplankton. *Limnology and Oceanography* 23:636–648.

SCAVIA, D. 1979. Examination of phosphorus cycling and control of phytoplankton dynamics in Lake Ontario with an ecological model. *Journal of Fisheries Research Board of Canada* 36:1336–1346.

SCHAFFNER, W.R. AND OGLESBY, R.T. 1978. Limnology of eight finger lakes: Hemlock, Canadice, Honeoye, Keuka, Seneca, Owasco, Skaneateles and Otisco. Pages 313–470 *in* J.A. Bloomfield, ed., *Lakes of New York State, Vol. 1. Ecology of the Finger Lakes*. Academic Press, New York, New York, USA. 499 pp.

SCHELSKE, C.L., DAVIS, C.O. AND FELDT, L.E. 1984. Growth responses of river and lake phytoplankton populations in Lake Michigan water. *Verhandlungen Internationale Verein Limnologie* 22:445–451.

SCHELSKE, C.L., FELDT, L.E., SANTIAGO, L.A. AND STOERMER, E.F. 1972. Nutrient enrichment and its effect on phytoplankton production and species composition in Lake Superior. Pages 149–165 in *Proceedings of the 15th Conference on Great Lakes Research*. International Association for Great Lakes Research, Ann Arbor, Michigan, USA.

SCHELSKE, C.L., FELDT, L.E. AND SIMMONS, M.S. 1980. *Phytoplankton and Physical-chemical Conditions in Selected Rivers and the Coastal Zone of Lake Michigan, 1972*. University of Michigan, Great Lakes Research Division, Publication No. 19. Ann Arbor, Michigan, USA. 162 pp.

SCHELSKE, C.L., FELDT, L.E., SIMMONS, M.S. AND STOERMER, E.F. 1974. Storm-induced relationships among chemical conditions and phytoplankton in Saginaw Bay and western Lake Huron. Pages 78–91 in *Proceedings of the 17th Conference on Great Lakes Research, McMasters University, Hamilton, Ontario, Canada, August 12–14, 1974*. International Association for Great Lakes Research, Ann Arbor, Michigan.

SCHELSKE, C.L. AND ROTH, J.C. 1973. *Limnological Survey of Lakes Michigan, Superior, Huron, and Erie*. University of Michigan, Great Lakes Research Division, Publication. No. 17. Ann Arbor, Michigan, USA. 108 pp.

SCHELSKE, C.L., SIMMONS, M.S. AND FELDT, L.E. 1975. Phytoplankton responses to phosphorus and silica enrichments in Lake Michigan. *Verhandlungen Internationale Verein Limnologie* 19:911–921.

SCHELSKE, C.L., STOERMER, E.F., GANNON, J.E. AND SIMMONS, M.S. 1976. *Biological, Chemical and Physical Relationships in the Straits of Mackinac*. U.S. Environmental Protection Agency, Ecological Research Series EPA 600/3-76-095. Environmental Research Laboratory, Duluth, Minnesota.

SCHENK, C.F. AND THOMPSON, R.E. 1965. *Long-term Changes in Water Chemistry and Abundance of Plankton at a Single Sampling Location in Lake Ontario*. Pages 197–208 *in* University of Michigan, Great Lakes Research Division Publication No. 13. Ann Arbor, Michigan, USA.

SCHMIDT, A. 1874–1959. *Atlas der Diatomaceen-kunde*. Heft 1–480. O. Reisland, Leipzig, Germany.

SCHMIDT, D.J. AND FEE, E. 1967. Planktonic diatoms from the Coralville Reservoir. *Proceedings of the Iowa Academy of Science* 74:17–19.

SCHULTZE, E.A. 1887. A descriptive list of Staten Island diatoms I. *Bulletin of the Torrey Botanical Club* 14:69–73.

SCHULTZE, E.A. 1887. A descriptive list of Staten Island diatoms II. *Bulletin of the Torrey Botanical Club* 14:109–114.

SCHULTZE, E.A. 1889. A descriptive list of Staten Island diatoms III. *Bulletin of the Torrey Botanical Club* 16:98–104.

SCHUMACHER, G.J. 1956. A qualitative and quantitative study of the plankton algae in southwestern Georgia. *American Midland Naturalist* 56:88–115.

SCHUMACHER, G.J. 1969. Algae of the Susquehanna River Basin in New York. *Bulletin of the New York State Museum and Science Service* 412:1–58.

SCHUMACHER, G.J., BELLIS, V.J. AND WHITFORD, L.A. 1963. Additions to the freshwater algae in North Carolina. VI. *Journal of the Elisha Mitchell Scientific Society* 75:101–106.

SCHUMACHER, G.J. AND WHITFORD, L.A. 1959. Additions to the freshwater algae in North Carolina. IV. *Journal of the Elisha Mitchell Scientific Society* 75:101–106.

SCHUMACHER, G.J. AND WHITFORD, L.A. 1961. Additions to the freshwater algae in North Carolina. V. *Journal of the Elisha Mitchell Scientific Society* 77:274–280.

SCHWARTZ, S.S., BLINN, D.W. AND JOHNSON, G. 1981. The physico-chemical and planktonic response of an algicide-treated shallow mountain lake in Arizona. *Internationale Revue der Gesamten Hydrobiologie* 66:249–262.

SEABURG, K.G. AND PARKER, B.C. 1983. Seasonal differences in the temperature ranges of growth of Virginia algae. *Journal of Phycology* 19:380–386.

SELL, D.W., CARNEY, H.J. AND FAHNENSTIEL, G.L. 1984. Inferring competition between natural phytoplankton

populations: the Lake Michigan example reexamined. *Ecology* 65:325–328.

SELLMAN, S.M., JOHANSEN, J.R. AND COBURN, M.M. 2002. Using fish to sample diatom composition in streams: are gut contents representative of natural substrates? Pages 529–536 *in* A. Economou-Amilli, ed., *Proceedings of the 16th International Diatom Symposium*. University of Athens, Greece.

SERVANT-VILDARY, S., FOURTANIER, E., KOCIOLEK, J.P. AND MACDONALD, M.M. 2001. Nomenclatural issues, types and conserved materials from Tempère and Peragallo's *Diatomées Du Monde Entier, Edition 2*. *Diatom Research* 16:363–398.

SEYFER, J.R. AND WILHM, J. 1977. Variation with stream order in species composition, diversity, biomass, and chlorophyll of periphyton in Otter Creek, Oklahoma. *The Southwestern Naturalist* 22:455–467.

SHAYLER, H.A. AND SIVER, P.A. 2004. Description of a new species of the diatom genus *Brachysira* (Bacillariophyta), *Brachysira gravida* sp. nov. from the Ocala National Forest, Florida, U.S.A. *Nova Hedwigia* 78:399–410

SHERMAN, B.J. AND PHINNEY, H.K. 1971. Benthic algal communities of the Metolius River. *Journal of Phycology* 7:269–273.

SHERO, B.R., PARKER, M. AND STEWART, K.M. 1978. The diatoms, productivity and morphometry of 43 lakes in New York State, USA. *Internationale Revue der Gesamten Hydrobiologie* 63:365–387.

SHOBE, W.R., STOERMER, E.F. AND DODD, J.D. 1963. Notes on Iowa diatoms IV. The diatoms in a northwest Iowa fen. *Proceedings of the Iowa Academy of Science* 70:71–74.

SICKO-GOAD, L. 1982. A morphometric analysis of algal response to low dose, short-term heavy metal exposure. *Protoplasma* 110:75–86.

SICKO-GOAD, L. 1985. Electron microscopy in the study of natural phytoplankton assemblages. Pages 620–623 in *43rd Annual Proceedings of the Electron Microscopical Society of America*.

SICKO-GOAD, L. 1986. Rejuvenation of *Melosira granulata* (Bacillariophyceae) from the anoxic sediments of Douglas Lake, Michigan. II. Electron microscopy. *Journal of Phycology* 22:28–35.

SICKO-GOAD, L., SCHELSKE, C.L. AND STOERMER, E.F. 1984. Estimation of intracellular carbon and silica content of diatoms from natural assemblages using morphometric techniques. *Limnology and Oceanography* 29:1170–1178.

SICKO-GOAD, L., STOERMER, E.F. AND KOCIOLEK, J.P. 1989. Diatom resting cell rejuvenation and formation: Time Course, species records and distribution. *Journal of Plankton Research* 11:375–389.

SICKO-GOAD, L., STOERMER, E.F. AND LADEWSKI, B. G. 1977. A morphometric method for correcting phytoplankton cell volume estimates. *Protoplasma* 93:147–163.

SILVA, H. 1953. Checklist of Tennessee diatoms to 1951. *Journal of the Tennessee Academy of Science* 28:78.

SILVA, H. AND SHARP, A.J. 1944. Some algae of the southern Appalachians. *Journal of the Tennessee Academy of Science* 19:337–345.

SIMONSEN, R. 1987. *Atlas and Catalogue of the Diatom Types of Friedrich Hustedt*, Vols. 1–3. Cramer, Berlin, Germany. 525 pp.

SIVER, P.A. 1977. Comparison of attached diatom communities on natural and artificial substrates. *Journal of Phycology* 13:402–406.

SIVER, P.A. 1978. Development of diatom communities on *Potamogeton robbinskii* Oakes. *Rhodora* 80:417–430.

SIVER, P.A., AHRENS, T.D., HAMILTON, P.B., STACHURA-SUCHOPLES, K. AND KOCIOLEK, J.P. 2004. The ecology of diatoms in ponds and lakes on the Cape Cod peninsula, Massachusetts, U.S.A., with special reference to pH. Pages 335–357 *in* M. Poulin, ed., *Proceedings of the 17th International Diatom Symposium. Ottawa, Canada, 25th-31st August 2002*. Biopress Ltd., Bristol, England.

SIVER, P.A., HAMILTON, P.B., STACHURA-SUCHOPLES, K. AND KOCIOLEK, J.P. 2003. Morphological observations of *Neidium* species with sagittate apices, including the description of *N. cape-codii* sp. nov. *Diatom Research* 18:131–148

SIVER, P.A., HAMILTON, P.B., STACHURA-SUCHOPLES, K. AND KOCIOLEK, J.P. 2005. Freshwater diatom floras of North America: Cape Cod, Massachusetts, U.S.A. *Diatomologica Iconographia* 14:1–463.

SKVORTZOW BV. 1937. Diatoms from Lake Michigan, I. The *American Midland Naturalist*. 18(4):652–658

SMITH, G.M. 1950. *The Freshwater Algae of the United States*, 2nd ed. McGraw–Hill, New York, New York, USA. 719 pp.

Smith, H.L. 1860. Notes on Diatomaceae found near Gambia, Ohio. *Transactions Microscopical Society London*, N.S., 8:33–35.

Smith, H.L. 1872. The Bailey Collection at the Boston Society of Natural History. *Monthly Microscopical Journal* 9:78.

Smith, H.L. 1872. Conspectus of the Diatomaceae. Analysis of the species of the genus *Amphora*. I. *The Lens* 1:1–19.

Smith H.L. 1873. Conspectus of the Diatomaceae. Analysis of the species of the genus *Amphora*. II. *The Lens* 2:65–91.

Smith, H.L. 1876–1888. *Diatomacearum Species Typicae*. Exsiccatae, slides. Numbers 1–750. Boston, Massachusetts, USA.

Smith, H.L. 1876–1888. *Diatomacearum Species Typicae*. Centuries I–VI, numbers 1–600; supplement numbers 601–750. Boston, Massachusetts, USA.

Smith, H.L. 1878. Description of new species of diatoms. *American Quarterly Microscopical Journal* 1:12–18.

Smith H.L. 1882. *Rhizosolenia gracilis*, n.sp. *Proceedings of the American Society of Microscopists* 5:177–178.

Smith, H.L. 1893. List of species and notes upon them. Pages 293–306 *in* B.W. Thomas, *Diatomaceae of Minnesota Inter-glacial Peat*. 20th Annual Report Minnesota Geological Survey.

Snow, E.C. 1932. A preliminary report on the algae of Utah Lake. *Proceedings of the Utah Academy of Science* 9:21–28.

Snow, E. and Stewart, G. 1939. A preliminary report of the algae of Mirror Lake. *Proceedings of the Utah Academy of Sciences, Arts and Letters* 16:113–115.

Soltero, R.A. and Wright, J.C. 1975. Primary production studies on a new reservoir; Bighorn Lake-Yellowtail Dam, Montana, U.S.A. *Freshwater Biology* 5:407–421.

Sommerfeld, M.R., Cisneros, R.M. and Olsen, R.D. 1975. The phytoplankton of Canyon Lake, Arizona. *The Southwestern Naturalist* 20:45–53.

Sovereign, H.E. 1958. The diatoms of Crater Lake, Oregon. *Transactions of the American Microscopical Society* 77:96–134.

Sovereign, H.E. 1963. New and rare diatoms from Oregon and Washington. *Proceedings of the California Academy of Sciences*, ser. 4, 31:349368.

Spaulding, S.A., Kociolek, J.P. and Davis, D. 2002. A new diatom genus from a playa lake in New Mexico, USA with the description of two new species. *European Journal of Phycology* 37:135–143.

Spaulding, S.A., Kociolek, J.P. and Wong, D. 1999. The genus *Muelleria* Frenguelli: A systematic revision, taxonomy and biogeography. *Phycologia* 38:314–341.

Spaulding, S.A. and Stoermer, E.F. 1997. Taxonomy and distribution of the genus *Muelleria* Frenguelli. *Diatom Research* 12:95–113.

Spencer, J.L. 1950. The net phytoplankton of Quabbin Reservoir, Massachusetts, in relation to certain environmental factors. *Ecology* 31:405–425.

Squires, L.E. and Rushforth, S.R. 1986. Winter phytoplankton communities of Utah Lake, Utah, USA. *Hydrobiologia* 131:235–248.

Squires, L.E., Rushforth, S.R. and Brotherson, J.D. 1979. Algal responses to a thermal effluent: study of a power station on the Provo River, Utah, U.S.A. *Hydrobiologia* 63:17–32.

Squires, L.E., Rushforth, S.R. and Endsley, C.J. 1973. An ecological survey of the algae of Huntington Canyon, Utah. *Brigham Young University Science Bulletin, Biological Series* 18:1–87.

Squires, L.E., Whiting, M.C., Brotherson, J.D. and Rushforth, S.R. 1979. Competitive displacement as a factor influencing phytoplankton distribution in Utah Lake, Utah. *Great Basin Naturalist* 39:245–252.

St. Clair, L.L. and Rushforth, S.R. 1976. The diatoms of Timpanogos Cave National Monument, Utah. *American Journal of Botany* 63:49–59.

St. Clair, L.L. and Rushforth, S.R. 1977. The diatom flora of Goshen warm spring ponds and wet meadows, Goshen, Utah, USA. *Nova Hedwigia* 28:353–425.

St. Clair, L.L. and Rushforth, S.R. and Allen, J.V. 1981. Diatoms of Oregon Caves National Monument, Oregon. *Great Basin Naturalist* 41:317–332.

St. Clair, L.L., Squires, L.E. and Rushforth, S.R. 1978. A comparative analysis of the diatom flora on the snail *Ampullaria cuprina* from the Goshen ponds, Utah. *Great Basin Naturalist* 38:211–214.

Stachura-Suchoples, K., Kociolek, J.P. and Siver, P.A. 2004. A new *Neidium* species from Florida (U.S.A.) and comparison with *N. densestriatum* (Østrup) Krammer. Pages 359–370 *in* M. Poulin, ed., *Proceedings of the 17th International Diatom Symposium. Ottawa, Canada, 25th–31st August 2002.* Biopress Ltd., Bristol, England.

Staker, R.D., Hoshaw, R.W. and Everett, L.G. 1974. Phytoplankton distribution and water quality indices for Lake Mead (Colorado River). *Journal of Phycology* 10:323–331.

Starks, T.L. and Shubert, L.E. 1982. Colonization and succession of algae and soil-algal interactions associated with disturbed areas. *Journal of Phycology* 18:99–107.

Starrett, W.C. and Patrick, R.M. 1952. Net plankton and bottom microflora of the Des Moines River, Iowa. *Proceedings of the Academy of Natural Sciences of Philadelphia* 104:219–243.

Steinman, A.D. and Lamberti, G.A. 1988. Lotic algal communities in the Mt. St. Helens region six years following eruption. *Journal of Phycology* 24:482–489.

Steinman, A.D. and Sheath, R.G. 1984. Morphological variability of *Eunotia pectinalis* (Bacillariophyceae) in a softwater Rhode Island stream and culture. *Journal of Phycology* 20:266–276.

Sterrenburg, A.S. 1991. Studies on the genera *Gyrosigma* and *Pleurosigma* (Bacillariophyceae). Light microscopical criteria for taxonomy. *Diatom Research* 6:367–389.

Stevenson, R.J. 1979. *Green Bay Phytoplankton Composition, Abundance and Distribution*. U.S. EPA-905/3-79-002.

Stevenson, R.J. 1983. Effects of current and conditions simulating autogenically changing microhabitats on benthic algal immigration. *Ecology* 64:1514–1524.

Stevenson, R.J. 1984. Epilithic and epipelic diatoms in the Sandusky River, with emphasis on species diversity and water pollution. *Hydrobiologia* 114:161–175.

Stevenson, R.J. 1984. How currents on different sides of substrates in streams affect mechanisms of benthic algal accumulation. *Internationale Revue des gesamten Hydrobiologie* 69:241–262.

Stevenson, R.J. 1985. *Phytoplankton Composition, Abundance and Distribution in Lake Huron*. U.S. EPA-905/3-85-004. 69 pp.

Stevenson, R.J. 1989. Variation in diatom community structure among habitats in sandy streams. *Journal of Phycology* 25:678–686.

Stevenson, R.J. 1990. Benthic algal community dynamics in a stream during and after a spate. *Journal of the North American Benthological Society* 9:277–288.

Stevenson, R.J. 1991. Emigration and immigration can be important in determinants of benthic diatom assemblages in streams. *Freshwater Biology* 26:279–294.

Stevenson, R.J. 1991. Effects of selective grazing by snails on benthic algal succession. *Journal of the North American Benthological Society* 10:430–443.

Stevenson, R.J. 1992. Responses of benthic algae to pulses in current and nutrients during simulations of subscouring spates. *Journal of the North American Benthological Society* 11:37–48.

Stevenson, R.J. 1993. *Diatom Indicators of Biotic Integrity and Trophic Conditions*. U.S. Environmental Protection Agency, Office of Research and Development ERL-Corvallis, Corvallis, Oregon, USA. 12 pp.

Stevenson, R.J. 1997. Scale-dependent dterminants and consequences of benthic algal heterogeneity. *Journal of the North American Benthological Society* 16:248–262.

Stevenson, R.J., Bothwell, M.I. and Lowe, R.L., eds. 1996. *Algal Ecology: Freshwater Benthic Ecosystems.* Academic Press, San Diego, California, USA.

Stevenson, R.J. and Hashim, S. 1989. Variation in diatom community structure among habitats in sandy streams. *Journal of Phycology* 25:678–686.

Stevenson, R.J. and Peterson, C.G. 1989. Variation in benthic diatom (Bacillariophyceae) immigration with habitat characteristics and cell morphology. *Journal of Phycology* 25:120–129.

Stevenson, R.J., Peterson, C.G., Kirschtel, D.B., King, C.C. and Tuchman, N.C. 1991. Density-dependent growth, ecological strategies and effects of nutrients and shading on benthic diatom succession in streams. *Journal of Phycology* 27:59–69.

Stevenson, R.J. and Pryfogle, P.A. 1975. A comparison of the winter diatom flora of the Sandusky River

and Tymochtee Creek. Pages 210–231 *in* D.B. Baker, W.B. Jackson, and B.L. Prater, eds., *Proceedings of Sandusky River Basin Symposium, May 2–3, 1975, Tiffin, Ohio.* International Reference Group on Great Lakes Pollution from land Use Activities, International Joint Commission. 1976-653-346. 475 pp.

Stevenson, R.J., Singer, R., Roberts, D.A. and Boylen, C.W. 1985. Patterns of benthic algal abundance with depth, trophic status, and acidity in poorly buffered New Hampshire lakes. *Canadian Journal of Fisheries and Aquatic Sciences* 42:1501–1512.

Stevenson, R.J. and Stoermer, E.F. 1978. Diatoms from the Great Lakes. II. Some rare or poorly known species of the genus *Navicula. Journal of Great Lakes Research* 4:175–185.

Stevenson, R.J. and Stoermer, E.F. 1981. Quantitative differences between benthic algal communities along a depth gradient in Lake Michigan. *Journal of Phycology* 17:29–36.

Stevenson, R.J. and Stoermer, E.F. 1982. Seasonal abundance patterns of diatoms on *Cladophora* in Lake Michigan. *Journal of Great Lakes Research* 8:169–183.

Stevenson, R.J. and Stoermer, E.F. 1982. Abundance patterns of diatoms on *Cladophora* in Lake Huron with respect to a point source of wastewater treatment plant effluent. *Journal of Great Lakes Research* 8:184–195.

Stewart, A.J. 1988. A note on the occurrence of unusual patches of senescent periphyton in an Oklahoma stream. *Freshwater Ecology* 4:395–399.

Stewart, A.J. and Blinn, D.W. 1976. Studies on Lake Powell, USA: environmental factors influencing phytoplankton success in a high desert warm monomictic lake. *Archiv für Hyrdrobiologie* 78:139–164.

Stockner, J.G. 1968. The ecology of a diatom community in a thermal stream. *British Phycological Journal* 3:501–514.

Stockner, J.G. and Benson, W.W. 1967. The succession of diatom assemblages in the recent sediments of Lake Washington. *Limnology and Oceanography* 12:513–532.

Stodder, C. and Greenleaf, R.C. 1861. Organisms found in the mud from the bottom of Mystic Pond, Medford, near Boston. *Proceedings of the Boston Society of Natural History* 8:119–121.

Stodder, C. 1867. Report upon the collection of Diatomaceae from the alpine summits of the White Mountains of New Hampshire. *Proceedings of the Boston Society of Natural History* 10:75.

Stodder, C. 1879. New diatoms. *American Monthly Microscopical Journal* 4:11.

Stoermer, E.F. 1962. Notes on Iowa diatoms. II. Species distribution in a subaerial habitat. *Proceedings of the Iowa Academy of Science* 69:87–96.

Stoermer, E.F. 1963. New taxa and new United States records of the diatom genus *Neidium* from West Lake Okoboji. *Notulae Naturae* 358:1–9.

Stoermer, E.F. 1964. Notes on Iowa diatoms. VII. Rare and little known diatoms from Iowa. *Proceedings of the Iowa Academy of Science* 71:55–66.

Stoermer, E.F. 1967. Polymorphism in *Mastogloia. Journal of Phycology* 3:73–77.

Stoermer, E.F. 1967. *An Historical Comparison of Offshore Phytoplankton Populations in Lake Michigan.* Pages 47–77 *in* Univesity of Michigan, Great Lakes Research Division, Special Report No. 30. Ann Arbor, Michigan, USA.

Stoermer, E.F. 1968. Nearshore phytoplankton populations in the Grand Haven, Michigan vicinity during thermal bar conditions. Pages 137–150 in *Proceedings of the 11th Conference on Great Lakes Research.* International Association for Great Lakes Research, Ann Arbor, Michigan, USA.

Stoermer, E.F. 1975. Comparison of benthic diatom communities in Lake Michigan and Lake Superior. *Verhandlungen Internationale Verein Limnologie* 19:932–938.

Stoermer, E.F. 1975. The effects of energy-related effluents on phytoplankton communities. Pages 409–422 in *Proceedings of the Second Federal Conference on the Great Lakes, March 25–27, 1975.* Interagency Committee on Marine Science and Engineering of the Federal Council for Science and Technology. 525 pp.

Stoermer, E.F. 1978. Diatoms from the Great Lakes. I. Rare or poorly known species of the genera *Diploneis, Oestrupia* and *Stauroneis. Journal of Great Lakes Research* 4:170–177.

Stoermer, E.F. 1978. Phytoplankton assemblages as indicators of water quality in the Laurentian Great Lakes. *Transaction of the American Microscopical Society* 97:2–16

Stoermer, E.F. 1981. Diatoms associated with bryophyte communities growing at extreme depths in Lake

Michigan. *Proceedings of the Iowa Academy of Science* 88:91–95.

STOERMER, E.F. 1984. Research on Great Lakes algal communities: problems from the past, lessons for the future. *Journal of Great Lakes Research* 10:143–155.

STOERMER, E.F. 1984. *Limnological Characteristics of Northern Lake Michigan, 1976. Part 2. Phytoplankton Population Studies*. Pages 127–245 *in* University of Michigan, Great Lakes Research Division, Special Report No. 95. Ann Arbor, Michigan, USA.

STOERMER, E.F. 1988. Algae and the environment: The Great Lakes case. Pages 58–83 *in* C. Lembi and R. Waaland, eds., *Algae and Human Affairs*. Cambridge University Press, New York, USA. 590 pp.

STOERMER, E.F. AND ANDRESEN, N.A. 1990. *Aulacoseira agassizii* in North America. *Nova Hedwigia Beihefte* 100:217–223.

STOERMER, E.F. AND ANDRESEN, N.A. 1995. *Diatom Studies Under EMAP Great Lakes*. U.S. Environmental Protection Agency, Office of Research and Development, MED-Duluth [Minnesota] and LLRS-Grosse Ile, MI [Michigan], USA. 82 pp.

STOERMER, E.F., ANDRESEN, N.A. AND SCHELSKE, C.L. 1992. Diatom succession in the recent studies of Lake Okeechobee, Florida, U.S.A. *Diatom Research* 7:367–386.

STOERMER, E.F., BOWMAN, M.M., KINGSTON, J.C. AND SCHAEDEL, A.L. 1974. *Phytoplankton Composition and Abundance in Lake Ontario During IFYGL*. University of Michigan, Great Lakes Research Division, Special Report No. 53. 373 pp.

STOERMER, E.F. AND HÅKANSSON, H. 1984. *Stephanodiscus parvus*: Validation of an enigmatic and widely misconstrued taxon. *Nova Hedwigia* 39:497–511.

STOERMER, E.F, HÅKANSSON, H. AND THERIOT, E.C. 1987. *Cyclostephanos* species new to North America: C. *tholiformis* sp. nov. and C. *costatilimbus* comb. nov. *British Phycological Journal* 22:349–358.

STOERMER, E.F., HÅKANSSON, H. AND THERIOT, E.C. 1988. Morphology and taxonomy of *Stephanodiscus conspicueporus* sp. nov. (Bacillariophyceae). *Transactions of the American Microscopical Society* 107:46–52.

STOERMER, E.F. AND JULIUS, M.L. 2004. Centric diatoms. Pages 562–594 *in* J.D. Wehr and R.G. Sheath, eds., *Freshwater Algae of North America. Ecology and CLassification.* Academic Press, New York, USA. 918 pp.

STOERMER, E.F., KOCIOLEK, J.P. AND CODY, W. 1990. *Cyclotubicoalitus undatus*, genus et species nova. *Diatom Research* 5:171–177.

STOERMER, E.F. AND KOPCZYNSKA, E. 1967. Phytoplankton populations in the extreme southern basin of Lake Michigan, 1962–1963. Pages 88–106 in *Proceedings of the 10th Conference on Great Lakes Research.* International Association for Great Lakes Research, Ann Arbor, Michigan.

STOERMER, E.F AND KREIS, R.G., JR. 1978. Preliminary checklist of diatoms (Bacillariophyta) from the Laurentian Great Lakes. *Journal of Great Lakes Research* 4:149–169.

STOERMER, E.F., KREIS, R.G., JR. AND ANDRESEN, N.A. 1999. Checklist of diatoms from the Laurentian Great Lakes. II. *Journal of Great Lakes Research* 25:515–566.

STOERMER, E.F., KREIS, R.G., JR. AND SICKO-GOAD, L. 1981. A systematic, quantitative, and ecological comparison of *Melosira islandica* O. Müll. with *M. granulata* (Ehr.) Ralfs from the Laurentian Great Lakes. *Journal of Great Lakes Research* 7:345–356.

STOERMER, E.F., KREIS, R.G., JR., THERIOT, E.C. AND LADEWSKI, T.B. 1983. *Phytoplankton Abundance, Species Distribution and Community Structure in Saginaw Bay and Southern Lake Huron in 1980.* U.S. EPA-600/S3-83-091.4 pp.

STOERMER, E.F., LADEWSKI, B.G. AND SCHELSKE, C.L. 1978. Population responses of Lake Michigan phytoplankton to nitrogen and phosphorus enrichment. *Hydrobiologia* 57:249–265.

STOEMER, E.F. AND LADEWSKI, T.B. 1976. *Apparent optimal Temperatures for the Occurrence of Some Common Phytoplankton Species in Southern Lake Michigan.* Pages 1–49 *in* University of Michigan, Great Lakes Research Division, Special Publication 18. Ann Arbor, Michigan, USA.

STOERMER, E.F. AND LADEWSKI, T.B. 1982. Quantitative analysis of shape variation in type and modern populations of *Gomphoneis herculeana. Nova Hedwigia Beihefte* 73:347–386.

STOERMER, E.F., LADEWSKI, T.B. AND KOCIOLEK, J.P. 1986. Further observations on *Gomphoneis*. Pages 205–213 *in* H. Ricard, ed., *Proceedings of the 8th International Diatom Symposium*. Koeltz, Koenigstein, Germany.

Stoermer, E.F., Schelske, C.L. and Feldt, L.E. 1971. Phytoplankton assemblage differences at inshore versus offshore stations in Lake Michigan, and their effects on nutrient enrichment experiments. Pages 114–118 in *Proceedings of the 14th Conference on Great Lakes Research.*

Stoermer, E.F. and Sicko-Goad, L. 1985. A comparative ultrastructural and morphometric study of six species of the diatom genus *Stephanodiscus*. *Journal of Plankton Research* 7:125–135.

Stoermer, E.F. and Stevenson, R.J. 1979. *Green Bay Phytoplankton Composition, Abundance and Distribution*. U.S. EPA Publication 905/3-79-002. 104 pp.

Stoermer, E.F., Taylor, S.M. and Callender, E. 1971. Paleoecological interpretations of diatom succession in Devils Lake, North Dakota. *Transactions of the American Microscopical Society* 90:195–206.

Stoermer, E.F. and Theriot, E.C. 1985. Phytoplankton distribution in Saginaw Bay. *Journal of Great Lakes Research* 11:132–142.

Stoermer, E.F. and Tuchman, M.L. 1979. *Phytoplankton Assemblages of the Nearshore Zone of Southern Lake Michigan*. U.S. Environmental Protection Agency, Technical Report No. EPA-905/3-79-001. 88 pp.

Stoermer, E.F. and Yang, J.J. 1969. *Plankton Diatom Assemblages in Lake Michigan*. University of Michigan, Great Lakes Research Division, Special Report No. 47. Ann Arbor, Michigan, USA. 168 pp.

Stoermer, E F. and Yang, J.J. 1970. *Distribution and Relative Abundance of Dominant Plankton Diatoms in Lake Michigan*. University of Michigan, Great Lakes Research Division, Publication No. 16. Ann Arbor, Michigan, USA. 64 pp.

Stoermer, E.F. and Yang, J.J. 1971. Contributions to the diatom flora of the Laurentian Great Lakes. I. New and little-known species of *Amphora* (Bacillariophyta, Pennatibacillariophyceae). *Phycologia* 10:397–409.

Sumner, W.T. and Fisher, S.G. 1979. Periphyton production in Fort River, Massachusetts. *Freshwater Biology* 9:205–212.

Swamikannu, X. and Hoagland, K.D. 1989. Effects of snail grazing on the diversity and structure of a periphyton community in a eutrophic pond. *Canadian Journal of Fisheries and Aquatic Sciences* 46:1698–1704.

Swift, D.R. and Nichols, R.B. 1987. *Periphyton and Water Quality Relationships in the Everglades Water Conservation Areas 1978–1982*. Technical Publication 87-2, South Florida Water Management District, West Palm Beach, Florida, USA. 44 pp.

Sze, P. and Kingsbury, J.M. 1972. Distribution of phytoplankton in a polluted saline lake, Onondaga lake, New York. *Journal of Phycology* 8:25–36.

Tanner, V. 1930. Freshwater biological studies at Utah Lake, Utah. *Proceedings of the Utah Academy of Science* 7:60–61.

Tanner, V. 1931. Freshwater biological studies at Utah Lake, Utah. No. 2. *Proceedings of the Utah Academy of Science* 8:198–203.

Tarapchak, S.J. and Stoermer, E.F. 1976. *Environmental Status of the Lake Michigan Region, vol 4; Phytoplankton of Lake Michigan*. Argonne National Laboratory, Argonne, Illinois, USA. Report #ANL/ES-40, vol 4. 211 pp.

Taylor, W.D., Hiatt, F.A., Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Thomas, R.W., Morris, M.K. and Williams, L.R. 1977. *Distribution of Phytoplankton in Florida Lakes*. U.S. EPA National Eutrophication Survey Working Paper 679. 113 pp.

Taylor, W.D., Hiatt, F.A., Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Thomas, R.W., Morris, M.K. and Williams, L.R. 1977. *Distribution of Phytoplankton in Alabama Lakes*. U.S. EPA-600/3-77-082, Ecological Research Series. 51 pp.

Taylor, W.D., Hiatt, F.A., Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Thomas, R.W., Morris, M.K. and Williams, L.R. 1978. *Distribution of Phytoplankton in Kentucky Lakes*. U.S. EPA-600/3-78-013, Ecological Research Series. 28 pp.

Taylor, W.D. and Wetzel, R.G. 1988. Phytoplankton community dynamics in Lawrence Lake of southwestern Michigan. *Archiv für Hydrobiologie*, Supplement 81:491–532.

Taylor, W.D., Williams, L.R., Hern, S.C., Lambou, V.W., Howard, C.L., Morris, F.A. and Morris, M.K. 1981. *Phytoplankton Water Quality Relationships in U.S. Lakes, Part VIII: Algae Associated with or Responsible for Water Quality Problems*. U.S. EPA-600/S3-80-100. 4 pp.

TAYLOR, W.R. 1935. Phytoplankton of Isle Royale. *Transactions of the American Microscopical Society* 54:83–97.

TAYLOR, W.R. AND COLTON, H.S. 1928. The phytoplankton of some Arizona pools and lakes. *American Journal of Botany* 15:596–614.

TEMPÈRE, J. AND PERAGALLO, H. 1889–1895. *Diatomées Collection.* Paris (Imp. Hy-Tribout). Pp. 1–304, 1–62.

TEMPÈRE, J. AND PERAGALLO, H. 1907–1915. *Diatomées du monde* entier 2nd Edition. Arcachon (Gironde). Pp. 1–480, 1–68.

TERRY, W.A. 1908. Additional lists of Connecticut diatoms. *Rhodora* 10:179–184.

TERRY, W.A. 1907. A partial list of Connecticut diatoms with some account of their distribution in certain parts of the state. *Rhodora* 9:125–140.

THERIOT, E.C. 1987. Principal component analysis and taxonomic interpretation of environmentally related variation in silicification in *Stephanodiscus* (Bacillariophyceae). *British Phycological Journal* 22:359–373.

THERIOT, E.C. 1988. An empirically based model of variation in rotational elements in centric diatoms with comments on ratios in phycology. *Journal of Phycology* 24:400–407.

THERIOT, E.C. 1992. Clusters, species concepts, and morphological evolution of diatoms. *Systematic Biology* 41(2):141–157.

THERIOT, E.C., HÅKANSSON, H. AND STOERMER, E.F. 1988. Morphometric analysis of *Stephanodiscus alpinus* (Bacillariophyceae) and its morphology as an indicator of lake trophic status. *Phycologia* 27:485–493.

THERIOT, E.C. AND STOERMER, E.F. 1981. Some aspects of morphological variation in *Stephanodiscus niagarae* (Bacillariophyceae). *Journal of Phycology* 17:64–72.

THERIOT, E.C. AND STOERMER, E.F. 1982. Observations on North American populations of *Stephanodiscus* (Bacillariophyceae) species attributed to Friedrich Hustedt. *Transactions of the American Microscopical Society* 101:368–374.

THERIOT, E.C. AND STOERMER, E.F. 1984. Principal component analysis of character variation in *Stephanodiscus niagarae* Ehrenb.: Morphological variation related to lake trophic status. Pages 97–112 *in* D.G Mann, ed., *Proceedings of the Seventh International Diatom Symposium.* O. Koeltz, Koenigstein, Germany. 541 pp.

THERIOT, E.C. AND STOERMER, E.F. 1984. Principal components analysis of *Stephanodiscus*: Observations on two new species from the *Stephanodiscus niagarae* complex. *Bacillaria* 7:37–58.

THERIOT, E.C. AND STOERMER, E.F. 1986. Morphological and ecological evidence for two varieties of *Stephanodiscus niagarae.* Pages 385–394 in *Proceedings of the 8th International Diatom Symposium.* O. Koeltz, Koenigstein, Germany.

THOMAS, B.W. 1890. Diatomaceae of Minnesota inter-glacial peat, with a list of species and some notes upon them by Prof. Hamilton L. Smith. *Minnesota Geological Survey Annual Report* 20:290–306.

THOMAS, B.W. AND CHASE, H.H. 1887. The diatomaceae of Lake Michigan as collected during the last 16 years from the water supply of the city of Chicago. *Notarisia* 2:328–330.

THOMASSON, K. 1962. Planktological notes from Western North America. *Archiv für Botanik* 4:437–463.

THOMASSON, K. 1964. Algae from lakes in northern Colorado. *Svensk Botanisk Tidskrift* 58:73–80.

THURLOW, D.L., DAVIS, R.B. AND SASSEVILLE, D.R. 1975. Primary productivity, phytoplankton populations and nutrient bioassays in China Lake, Maine, USA. *Verhandlungen Internationale Verein Limnologie* 19:1029–1036.

TILDEN, J.E. 1894–1909. *American Algae.* Exsiccatae. Specimens dried on paper, numbers 1–650. Minneapolis, Minnesota, USA.

TILDEN, J.E. 1894–1909. *American Algae*. Centuries I–VII, numbers 1–850. Minneapolis, Minnesota, USA.

TIFFANY, L.H. AND BRITTON, M.E. 1952. *The Algae of Illinois*. University of Chicago Press, Chicago, Illinois, USA. 407 pp.

TILMAN, D. 1981. Tests of resource competition theory using four species of Lake Michigan algae. *Ecology* 62:802–815.

TRESSLER, W.L., TIFFANY, L.H. AND SPENCER, W.P. 1940. Limnological studies of Buckeye Lake, Ohio. *Ohio Journal of Science* 40:261–290.

TROEGER, W.W. 1978. Epiphytic diatoms in farm ponds and experimental ponds in Bryan County, Oklahoma.

Proceedings of the Oklahoma Academy of Science 58:64–68.

Troeger, W.W. 1983. Colonization of benthic diatoms in a new farm pond and its feeder creek. *The Southwestern Naturalist* 28:244–248.

Troeger, W.W. and Menzel, R.G. 1986. Benthic diatoms in two eutrophic flood detention reservoirs in Oklahoma. *Journal of Freshwater Ecology* 3:503–510.

Tuchman, M. and Blinn, D.W. 1979. Comparison of attached algal communities on natural and artificial substrata along a thermal gradient. *British Phycological Journal* 14:243–254.

Tuchman, M.L. and Stevenson, R.J. 1980. Comparison of clay tile, sterilized rock and natural substrate diatom communities in a small stream in southeastern Michigan, USA. *Hydrobiologia* 75:73–79.

Tuchman, M.L., Stoermer, E.F. and Carney, H.J. 1984. Effects of increased salinity on the diatom assemblage of Fonda Lake, Michigan. *Hydrobiologia* 109:179–188.

Tuchman, N.C. and Stevenson, R.J. 1991. Effects of selective grazing by snails on benthic algal succession. *Journal of the North American Benthological Society* 10:430–443.

Valentin, S., Wasson, J.G. and Philippe, M. 1995. Effects of hydropower peaking on epilithon and invertebrate community trophic structure. *Regulated Rivers* 10:105–119.

Van Heurck, H. 1880. *Synopsis des diatomées de Belgique*. Atlas, Plates 1–30. Dukaju, Anvers, Belgium.

Van Heurck, H. 1881. *Synopsis des diatomées de Belgique*. Atlas, Plates 31–77. Dukaju, Anvers, Belgium.

Van Heurck, H. 1882. *Synopsis des diatomées de Belgique*. Atlas, Plates 78–103. Dukaju, Anvers, Belgium.

Van Heurck, H. 1883. *Synopsis des diatomées de Belgique*. Atlas, Plates 104–132. Dukaju, Anvers, Belgium.

Van Heurck, H. 1884. *Synopsis des diatomées de Belgique*. Table alphabetique. Dukaju, Anvers, Belgium. 120 pp.

Van Heurck, H. 1885. *Synopsis des diatomées de Belgique*. Atlas. Texte, Plates A, B, C. Dukaju, Anvers, Belgium.

Van Heurck, H. and Grunow, A. 1882–1885. *Types du Synopsis des Diatomees de Belgique*. Exsiccatae. Slides 1–550.

VanLandingham, S.L. 1968. Investigation of a diatom population from mine tailings in Nye County, Nevada, U.S.A. *Journal of Phycology* 4:306–310.

VanLandingham, S.L. 1964. Some physical and generic aspects of fluctuations in non-marine plankton diatom populations. *American Journal of Botany* 30:437–478.

VanLandingham, S.L. 1965. Diatoms from Mammoth Cave, Kentucky. *International Journal of Speleology* 1:517–539.

VanLandingham, S.L. 1966. Three new species of *Cymbella* from Mammoth Cave, Kentucky. *International Journal of Speleology* 2:133–136.

VanLandingham, S.L. 1967. A new species of *Gomphonema* (Bacillariophyta) from Mammoth Cave, Kentucky. *International Journal of Speleology* 2:405–406.

VanLandingham, S.L. 1968. Investigation of a diatom population from mine tailings in Nye County, Nevada, U.S.A. *Journal of Phycology* 4:306–310.

VanLandingham, S.L. 1987. Observations on the ecology and trophic status of Lake Tahoe (Nevada and California) based on the algae from three independent surveys. *Great Basin Naturalist* 47:562–582.

Van Oosten, J. 1957. *Great Lakes Fauna, Flora, and Their Environment—a Bibliography*. Great Lakes Commission, Ann Arbor, Michigan, USA. 86 pp.

Vansteenburg, J.B., Luttenton, M.R. and Rada, R.G. 1984. A floristic analysis of the attached diatoms in selected areas of the Upper Mississippi River. *Proceedings of the Iowa Academy of Science* 91:52–56.

Vaughn, J.C. 1961. Coagulation difficulties of the south district filtration plant. *Pure Water* 13:45–49.

Verb, R.G. and Vis, M.L. 2000. Comparison of benthic diatom assemblages from stream draining abandoned and reclaimed coal mines and nonimpacted sites. *Journal of the North American Benthological Society* 19:274–288.

Verch, R. and Blinn, D.W. 1971. Seasonal investigations of algae from Devils Lake, North Dakota. *Prairie Naturalist* 3:67–79.

Volker, R.P. 1962. Preliminary aspects of an ecological investigation of Lake East Okoboji, Iowa. *Proceedings of the Iowa Academy of Science* 69:99–107.

Vollenweider, R.A., Munawar, M. and Stadelman, P. 1974. A comparative review of phytoplankton and

primary production in the Laurentian Great Lakes. *Journal of the Fisheries Research Board of Canada* 31:739–762.

VORCE, C.M. 1881. Forms observed in water of Lake Erie. *Transactions of the American Microscopical Society* 4:51–90.

VORCE, C.M. 1882. Microscopic forms observed in the waters of Lake Erie. *Proceedings of the American Society of Microscopists* 5:187–196.

VOSHELL, JR., J.R. AND PARKER, C.R. 1985. Qunatity and quality of seston in an impounded and a free-flowing river in Virginia, U.S.A. *Hydrobiologia* 122:271–280.

VYMAZAL, J., CRAFT, C.B. AND RICHARDSON, C.J. 1994. Periphyton response to nitrogen and phosphorus additions in the Florida Everglades. *Algological Studies* 73:75–97.

WAGER, D.B. AND SCHUMACHER, G.J. 1970. Phytoplankton of the Susquehanna River near Binghamton, New York: Seasonal variations, effects of sewage effluents. *Journal of Phycology* 6:110–117.

WALKER, G.K., SICKO-GOAD, L. AND STOERMER, E.F. 1978. Intercalary band formation and cell growth in the diatom *Fragilaria capucina*. *Microbios Letters* 9:147–154.

WALKER, G.K., SICKO-GOAD, L. AND STOERMER, E.F. 1979. An ultrastructural examination of the pennate diatom *Caloneis amphisbaena*. *Microbios Letters* 12:141–152.

WALKER, W.C. AND CHASE, H.H. 1886. *Notes on New and Rare Diatoms*. Curtiss and Childs Print, Utica, New York, USA. 6 pp.

WALLACE, J.H. 1960. New and variable diatoms. *Notulae Naturae* 331:1–8.

WALLACE, J.H. AND PATRICK, R.M. 1950. A consideration of *Gomphonema parvulum* Kütz. *Butler University Botanical Studies* 9:227–234.

WALLEN, D.G. 1990. The toxicity of chromium (VI) to photosynthesis of the phytoplankton assemblage of Lake Erie and the diatom *Fragilaria crotonensis* Kitton. *Aquatic Botany* 38:331–340.

WALLEN, D G. 1996. Adaptation of the growth of the diatom *Fragilaria crotonensis* Kitton and the phytoplankton assemblage of Lake Erie to chromium toxicity. *Journal of Great Lakes Research* 22:55–62.

WALLEN, I.E. 1949. The plankton population of a small fertile pond in central Oklahoma. *Transactions of the American Microscopical Society* 68:200–205.

WARD, H.B. 1896. A biological examination of Lake Michigan in the Traverse Bay region. *Bulletin of the Michigan Fisheries Commission* 6:1–71.

WARD, J.V. 1976. Comparative limnology of differentially regulated sections of a Colorado mountain river. *Archiv für Hydrobiologie* 78:319–342.

WARD, J.V. 1986. Altitudinal zonation in a Rocky Mountain stream. *Archiv für Hydrobiologie*, Supplement 74:133–199.

WARD, J.V. AND DUFFORD, R.G. 1979. Longitudinal and seasonal distribution of macroinvertebrates and epilithic algae in a Colorado springbrook-pond system. *Archiv für Hydrobiologie* 86:284–321.

WEBBER, E.E. 1961. A list of algae from selected areas in Massachusetts. *Rhodora* 63:275–281.

WEBBER, H.J. 1889. The fresh water algae of the plains. *American Naturalist* 23:1011–1013.

WEBBER, H.J. 1890. Catalogue of the Flora of Nebraska: Protophyta-Anthophyta. Pages 35–162 in *Report of the Botanist, Nebraska Board of Agriculture*. Lincoln, Nebraska, USA.

WEBER, C.I. 1970. A new freshwater centric diatom *Microsiphona potamos* gen. et sp. nov. *Journal of Phycology* 6:149–153.

WEBER, C.I. 1971. *A Guide to the Common Diatoms at Water Pollution Surveillance System Stations*. U.S. Environmental Protection Agency, Cincinnati, Ohio, USA. 98 pp.

WEBER, C.I., AND MOORE, D.R. 1967. Phytoplankton, seston and dissolved organic carbon in the Little Miami River at Cincinnati, Ohio. *Limnology and Oceanography* 12:311–318.

WEBER, H.J. 1889. The freshwater algae of the plains. *American Naturalist* 23:1011–1013.

WEED, W.H. 1899. The diatom marshes and diatom bed of the Yellowstone National Park. *Botanical Gazette* 14:117–120.

WENKE, T.L. AND EBERLE, M.E. 1985. Diatoms from Kansas. *The Southwestern Naturalist* 30:464–465.

WENKE, T.L. AND EBERLE, M.E. 1986. Diatoms from streams in Ellis and Russell Counties, Kansas. *Transactions of the Kansas Academy of Science* 89:162–168.

WHIPPLE, G.C. 1894. Some observations on the growth of diatoms. *Technology Quarterly* 7:214–231.

Whitford, L.A. 1956. The communities of algae in the springs and spring streams of Florida. *Ecology* 37:433–442.

Whitford, L.A. 1958. Phytoplankton in North Carolina lakes and ponds. *Journal of the Elisha Mitchell Science Society* 74:143–157.

Whitford, L.A. and Schumacher, G.J. 1963. Communities of algae in North Carolina streams and their seasonal relations. *Hydrobiologia* 22:133–196.

Whitford, L.A. and Schumacher, G.J. 1973. *A Manual of Fresh-water Algae*. Sparks Press, Raleigh, North Carolina, USA.

Whitmore, T.J. 1989. Florida diatom assemblages as indicators of trophic state and pH. *Limnology and Oceanography* 34:882–895.

Wilhm, J., Cooper, J. and Namminga, H. 1978. Species composition, diversity, biomass, and chlorophyll of periphyton in Greasy Creek, Red Rock Creek, and the Arkansas River, Oklahoma. *Hydrobiologia* 57:17–23.

Wilhm, J., Dorris, T., Seyfer, J.R. and McClintock, N. 1977. Seasonal variation in plankton populations in the Arkansas River near the confluence of Red Rock Creek. *The Southwestern Naturalist* 22:411–420.

Williams, D.M. 1985. Morphology, taxonomy and inter-relationships of the ribbed araphid diatoms from the genera *Diatoma* and *Meridion* (Diatomaceae: Bacillariophyta). *Bibliotheca Diatomologica* 8:1–228.

Williams, D.M. and Round, F.E. 1987. Revision of the genus *Fragilaria. Diatom Research* 2:267–288.

Williams L.G. 1964. Possible relationships between plankton-diatom species numbers and water-quality estimates. *Ecology*. 45:809–823.

Williams L.G. 1972. Plankton diatom species biomasses and the quality of American rivers and the Great Lakes. *Ecology*. 53:1038–1050.

Williams, L.G. and Scott, C. 1962. Principal diatom of major waterways of the United States. *Limnology and Oceanography* 7:365–379.

Williams, L.R. Hern, S.C., Lambou, V.W., Morris, F.A., Morris, M.K. and Taylor, W.D. 1978. Phytoplankton water quality relationships in U.S. lakes, Part II: Genera *Acanthosphaera* through *Cystodinium*. National Eutrophication Survey Working Paper No. 706. U.S. E.P.A., Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. 116 pp.

Williams, L.R., Hern, S.C., Lambou, V.W., Morris, F.A., Morris, M.K. and Taylor, W.D. 1979. *Distribution of Phytoplankton in Kansas Lakes*. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, USA. Report No. EPA-600/3-79-063. 45 pp.

Williams, L.R., Taylor, W.D., Hiatt, F.A., Hern, S.C., Hilgert, J.W., Lambou, V.W., Morris, F.A., Thomas, R.W. and Morris, M.K. 1977. *Distribution of Phytoplankton in Mississippi Lakes*. U.S. EPA-600/3-77-101, Ecological Research Series. 29 pp.

Williams, L.R.,Morris, F.A., Hilgert, J.W., Lambou, V.W., Hiatt, F.A., Taylor, W.D., Morris, M.K. and Hern, S.C. 1978. *Distribution of Phytoplankton in New Jersey Lakes*. U.S. EPA–600/3–78–014, Ecological Research Series. 59 pp.

Williams, S.L., Colon, E.M., Kohberger, R.C. and Clesceri, N.L. 1973. Response of plankton and periphyton diatoms in Lake George (N.Y.) to the inputs of nitrogen and phosphorus. Pages 441–466 in *Eastern Deciduous Forest Biome International Biological Program*, Contribution 38. Rennsalear Fresh Water Institute at Lake George, FWI Report 71-8. Rensselaer Polytechnic Institute, Troy, New York, USA.

Willson, D. and Forest, H.S. 1957. An exploratory study on soil algae. *Ecology* 38:309–313.

Woodson, B.R. 1969. Algae of a freshwater Virginia pond. *Castanea* 34:352–374.

Woodson, B.R. and Holoman, V.A. 1964. Systematic and ecological survey of algae in Chesterfield County, Vir. *Virginia Journal of Science* 15:51–70.

Woodson, B.R. and Holoman, V. 1965. Additions to the fresh-water algae in Virginia. *Virginia Journal of Science*, n.s., 16(2):146–164.

Woodson, B.R., Holoman, V. and Quick, A. 1966. Additions to freshwater algae of Virginia. II. Dinwiddie County. *Journal of the Elisha Mitchell Science Society* 82:154–159.

Woodson, B.R. and Wilson, W., Jr. 1973. A systematic and ecological survey of algae two streams of Isle of Wight County, Virginia. *Castanea* 38:1–18.

Wolle, F. 1889. Fourth contribution to the knowledge of Kansas algae. *Bulletin of the Washburn College*

Laboratory of Natural History 2:64.

Wolle, E 1890 *Diatomaceae of North America.* Comenius Press, Bethelem, Pennsylvania, USA. 42 pp.

Workman, G.W. and Sigler, W.F. 1965. Net-plankton of the Bear Lake littoral zone, Utah-Idaho. *Proceedings of the Utah Academy of Sciences, Arts, and Letters* 42:74–84.

Wright, J.C. 1958. The limnology of Canyon Ferry Reservoir. I. Phytoplankton-zooplankton relationships in the euphotic zone during September and October, 1956. *Limnology and Oceanography* 3:150–159.

Wujek, D.E. 1965. A contribution to the diatom flora of Kansas. *The Southwestern Naturalist* 10:39–41.

Wujek, D.E. 1967. Some plankton diatoms from the Detroit River and western end of Lake Erie adjacent to the Detroit River. *Ohio Journal of Science* 67:32–36.

Wujek, D.E., Chapo, M.S. and Reinke, D.C. 1980. New records and distributional notes on diatoms from western Kansas. *Technical Publications of the State Biological Survey of Kansas* 9:90–109.

Wujek, D.L, and Graebner, M. 1980. A new freshwater species of *Chaetoceros* from the Great Lakes region. *Journal of Great Lakes Research* 6:260–262.

Wujek, D.L. and Rupp, R.F. 1980. The diatoms of the Tittabawassee River, Michigan. *Bibliotheca Phycologica* 50:1–100.

Wujek, D.L., Rupp, P.M., Lenon, H.L., King, R.H. and Bailey, R.E. 1980. Phytoplankton of the Tittabawassee River, Michigan. *Phytologia* 45:255–269.

Wujek, D.L. and Wee, J.L. 1984. New, rare and unusual algae from Montana. *Northwest Science* 58:213–221.

Wujek, D.E. and Welling, M.L. 1981. The occurrence of two centric diatoms new to the Great Lakes. *Journal of Great Lakes Research* 7:55–56.

Wyman, J. 1883. Fresh-water algae and diatomaceae of Minneapolis, Minnesota. *American Monthly Microscopical Journal* 4:18.

Yearsley, K.H., Rushforth, S.R. and Johansen, J.R. 1992. Diatom flora of Beaver Dam Creek, Washington County, Utah, USA. *Great Basin Naturalist* 52:131–138.

Yeatman, H.C. 1956. Plankton studies on Woods reservoir, Tennessee. *Journal of the Tennessee Academy of Science* 31:32–49.

Young, O.W. 1945. A limnological investigation of periphyton in Douglas Lake, Michigan. *Transactions of the American Microscopical Society* 64:1–20.

Young, O.W. 1947. Notes on periphyton of Ogden River. *Proceedings of the Utah Academy of Sciences, Arts and Letters* 24:137.

Young, O.W. 1948. Observations on periphyton of Ogden River. *Proceedings of the Utah Academy of Sciences, Arts and Letters* 25:171–172.

Yount, J.L. 1956. Factors that control species numbers in Silver Springs, Florida. *Limnology and Oceanography* 1:286–295.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 28, pp. 527–556, 29 figs., 2 tables. December 30, 2005

Physical Geography of the Gaoligong Shan Area of Southwest China in Relation to Biodiversity

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The Gaoligong Shan mountains (Gaoligong Shan) comprise the western-most part of the Hengduan Mountain Range. They include all of the contiguous ridges west of the Nujiang River and east of the Irrawadi-Nmai Rivers and lie at the junction of the Indo-Malaya and Palearctic zoogeographic realms. The Gaoligong Shan are one of the world's most significant biodiversity hotspots outside of the tropics.

The Hengduan Mountains, of which the Gaoligong Shan are a part, are a result of the collision of the South China Block and Eurasian Plate during the late Mesozoic. During the Cenozoic, the Gaoligong Shan have also been affected by the continuing movements of the Indo-Australasian Plate and Eurasian Plates to the west of the Hengduan Mountains.

The Gaoligong Shan are characterized by a number of unusual features. Their high, contiguous ridges extend further south than do most of those of the other Hengduan Mountains. Also, their river valleys are unusually narrow and deep because they are incised into hard rock that maintains steep slope profiles. Continuing uplift, steep gradients, and swiftly flowing rivers have eroded deep gorges. The north-south orientation of the river valleys causes the Gaoligong Shan to have an unusual face aspect relative to the sun; nearly all slopes face either east or west. The deep valleys and north-south orientation of the ridges result in the region having a more moderate climate than surrounding non-mountainous areas situated at the same latitude. Because of their antiquity, the Gaoligong Shan have accumulated a high level of biodiversity. At the same time, their high elevations and deep gorges have acted as barriers to migration for most terrestrial organisms. Moreover, because of their unusual climate and many protected environments, the Gaoligong Shan provide a refugium from global climate perturbations. It is significant that the difficult terrain has, until recently, deterred extensive human habitation, thus preserving the region's biodiversity.

KEYWORDS: Gaoli Gongshan, Gaoligongshan, Hengduan Mountains, Biodiversity Hotspot, Climate, Refugia, Indian Plate, Australasian Plate, Eurasian Plate, Tibetan Plateau, GIS, Conservation, Biogeography.

The Gaoligong Shan mountains (GLGS) are widely acknowledged as an important center of biodiversity and as such have been recognized as a World Heritage Site (UNESCO 2003). The listing recognizes the region's unusual geological context, ecological diversity, and scenic beauty. Although many authors have written about the GLGS, there is no general agreement as to the geographical definition of the region. This paper presents such a definition.

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Ecologists recognize that the interplay of many factors is responsible for the accumulation of biodiversity. The prime factor is the environmental gradient produced by latitude and its effect on trophic production. The effect of latitude is modified by elevation and climatic variation due to local factors and ecological niche structure and complexity. The degree of isolation of the environment controls interchange of species along the trophic levels. The age of the environment and its biotic components also promote biotic heterogeneity. Competition and predation interact with the niche structure to form biotic communities with various degrees of complexity. Generally, the older and more stable the area, the greater the biodiversity. Many aspects of mountain ecology serve to exaggerate the complexity of niche structure. Although many authors have alluded to different aspects of the ecology of the GLGS, none has reviewed them comprehensively in terms related to the physical geography. In this paper, the relationship of geography to ecologyis investigated with respect to the promotion and maintenance of biodiversity.

In addition, the region's plate tectonics and geology are described. These two factors explain how the physical geography of the GLGS evolved. Tectonics causes rocks from different places to be brought together, building mountains or creating areas of subduction. The composition of the rocks dictates how they will behave as they are uplifted and eroded. Erosion of rocks contributes to soil formation, and the kind of soil formed is, in part, dependent on geology. The soils of the GLGS, therefore, are reviewed because of their bearing on biodiversity. The conformation of mountains and rivers has important biological consequences for the high levels of biodiversity in GLGS.

General Considerations

The purpose of this paper is to define the GLGS more accurately than has been done previously. This requires a starting point. Broadly speaking, the GLGS, as referred to here, are the most westerly ridges of the Hengduan Mountains that extend north to south between the Nujiang River in the east and the Irrawadi River in the west.

The name Gao–Li–Gong–Shan[1], strictly speaking, applies to a single peak at the junction of Baoshan, Lushui, and Tengchong Counties at approximately 25.133°N, 98.716°E. The exclusive

[1] In contracting Chinese names, I have used the established method of Zhao (1986) who suggested that names should not be contracted to less than two characters using the example of the Tian Shan Mountains, which he thought was preferable to Tian Mountains even though Shan means Mountains. Similarly, here I use Nujiang River rather than the Nu River despite the fact that "jiang" means river. This follows the most common usage of the name in the non-Chinese literature.

Gao–高–Li–黎–Gong–贡–Shan–山

The name Gaoligong Shan in Chinese is complicated. It, like many Chinese names, has different layers of meaning. It can mean, literally, and based on the characters alone, High Multitude Tribute Mountain. The character Li that is used, is the same as the one used for the transliteration Li in the name of the people called Lisu and who are the dominant ethnic minority group of the area. The exclusive usage in Chinese is that Gaoligong Shan implies the whole range of which Mount Gaoligong Shan is in the middle. The alternative term that could be used is Shanmai, which means mountain range in Chinese. This would give the rather cumbersome and never used term Gaoligong Shanmai or more correctly, but even worse sounding, Gaoligong Shan Shanmai. In this paper, the name used for the whole range will also be Gaoligong Shan (GLGS); I recommend that alternative names, sometimes seen in print, should be avoided, e.g. "Gaoli's," "Gaoligong," "Gaoli Gongshan," or just "Gongshan." "Mount Gaoligong Shan" should be used for the single peak if needed.

Another point: names in this region are difficult because of diverse ethnicities and dialects, e.g., the commonly referred to name Gongshan, is used sometimes for the mountains, at other times the county seat for the administrative zone, and most often, as an abbreviation for an administrative zone itself. This is the Gongshan Dulong Nuzu Zizhixian. Sometimes the Gongshan administrative zone is referred to as the Dulong area. Officially, it should be the Gongshan Drungzu Nuzu Zizhixian (Carto. Pub. Hse 1984), and in this paper it will be referred to as (Gongshan County). Drung, Dulong, and even Delung are the name for same people but spelled in different dialects. The name used can have many implications (Gros 2004). In this paper, place names are given to be as informative as possible to the general reader (see also cartography section in the main text). Lastly, GLGS is used in the plural to signify the whole range, as we do for the Rocky Mountains of the western United States.

Carto. Pub. Hse (1984). *Map of the People's Republic of China*. Cartographic Publishing House, Beijing; Esselte Map Service AB, Sweden.
Gros, S. (2004). The Politics of Names: The Identification of the Dulong (Drung) of Northwest Yunnan. China Information. *The Documentation and Research Centre for Modern China, Sinological Institute, Leiden University* **18**(2):275-302.

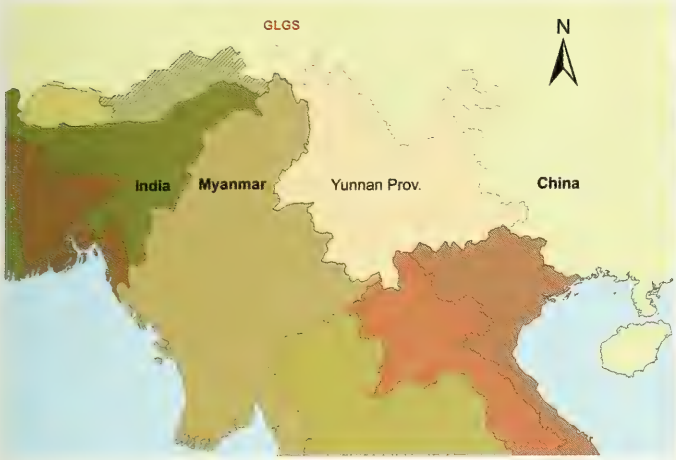


FIGURE 1. Regional locator map showing the Gaoligong Shan highlighted in relation to political geography.

FIGURE 2. Locator map showing the Gaoligong Shan highlighted in relation to local political geography.

usage in Chinese is that Gaoligong Shan includes the whole range of mountains of which the peak named Gaoligong Shan is in the middle. Chinese does not distinguish between plural and singular.

The GLGS are a poorly known biodiversity hotspot in Southwest China located mostly in Yunnan Province. They are the most biodiversity-rich area (Lan and Dunbar 2000; Mackinnon et al. 1996) of Yunnan, which is China's most biodiverse province (Zhang and Lin 1985) (see Figs. 1 and 2). The GLGS occupy about 10.5% of Yunnan Province.

The GLGS are a rugged mountainous border region adjoining Myanmar on the northeast. From a biogeographic perspective, the GLGS form the junction of several biogeographical realms, the Indo-Malayan, and Palearctic, and the biogeographical provinces of the Tibetan Plateau and South China subregion. The GLGS also stand at the junction of three major tectonic plates, which are discussed below, and, thus, three geological provinces. This position has given them an interesting and complex geological structure.

The formation of the Hengduan Mountains, of which the GLGS are a part, preceded the uplift of the Qinghai-Xizang (Tibetan) Plateau. However, today the GLGS are, more or less, an extension of the Tibetan Plateau, which extends far to the south into Yunnan (see shaded area in Fig. 3). Subsequent to the uplift of the Plateau, the Hengduan Mountains and GLGS

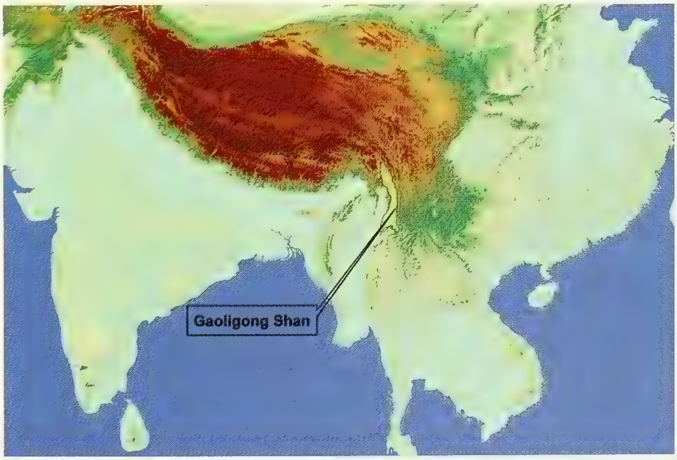


FIGURE 3. Regional locator map showing the Gaoligong Shan highlighted in yellow to the south of the Tibetan Plateau and to the west of the rest of the Hengduan Mountains.

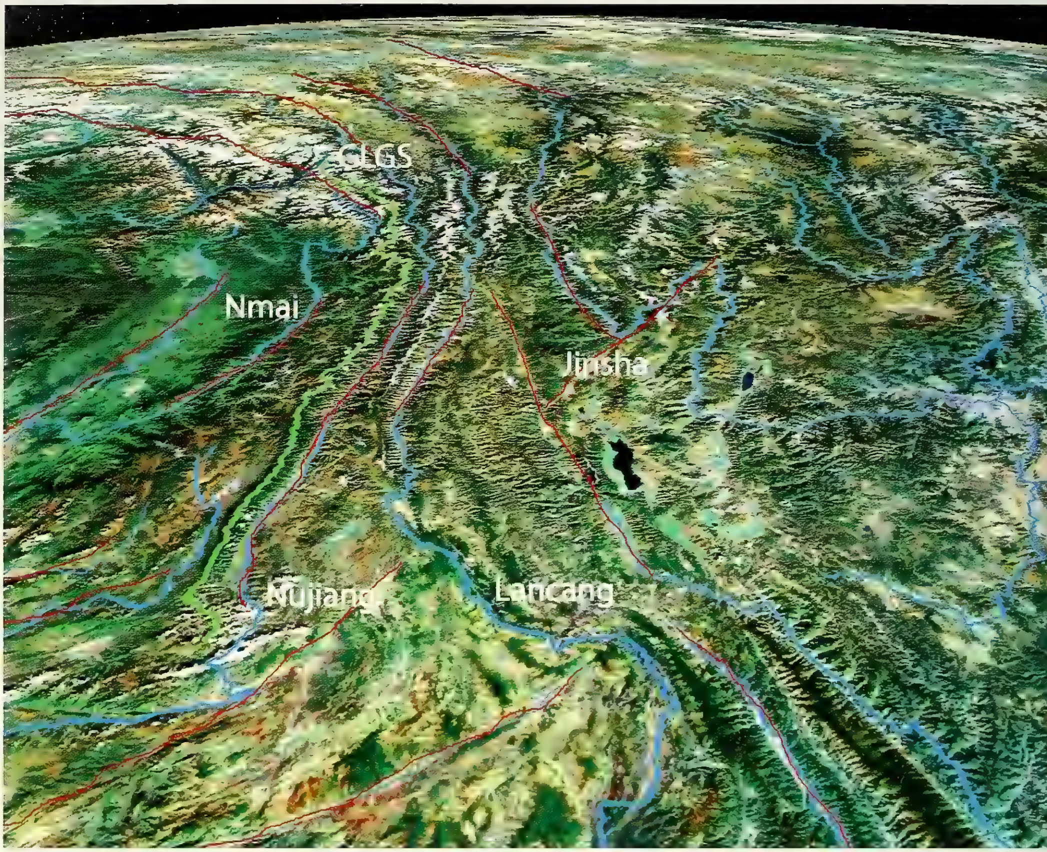


FIGURE 4. Satellite Image of Hengduan Mountains centered on Mt Gaoligong Shan, the Nujiang River can be seen entering the snow covered Tibetan Plateau at the top of the image (NASA 2004a).

experienced uplift, which has continued throughout much of the Cenozoic, and is associated with the Himalayan orogeny. The region is divided by a few large north-south flowing rivers, which are of major importance to Southeast Asia. The rivers run in extremely deep, gorges, which, having cut into the uplifting mountainous area, gave rise to a series of narrow, north-south-oriented, high mountain ridges. The rivers, which are associated with major fault zones (see Fig. 4), divide the area biogeographically.

TECTONICS

The north-south orientation of the Hengduan Mountains is orthogonal to the predominant east-west mountains found throughout eastern Eurasia. The Chinese name "Hengduan" translates as the "Transverse" or "Transecting" Mountains. The GLGS comprise the most westerly mountain ridge of the Hengduan Mountains.

EARLY TECTONIC MOVEMENTS.— The Hengduan Mountains were formed by several different major tectonic events. The mountains are at the margins of several plates, the Eurasian Plate to the north, the Indochina Block to the south, and the Indian Plate to the west. These plates are constrained by the Philippine-Pacific Plates to the east, and the Australasian Plate to the south (Hall 1997). These plates are all moving relative to the stable Eurasian Plate. The Hengduan Mountains region, being at the plate margins, is an active earthquake zone.

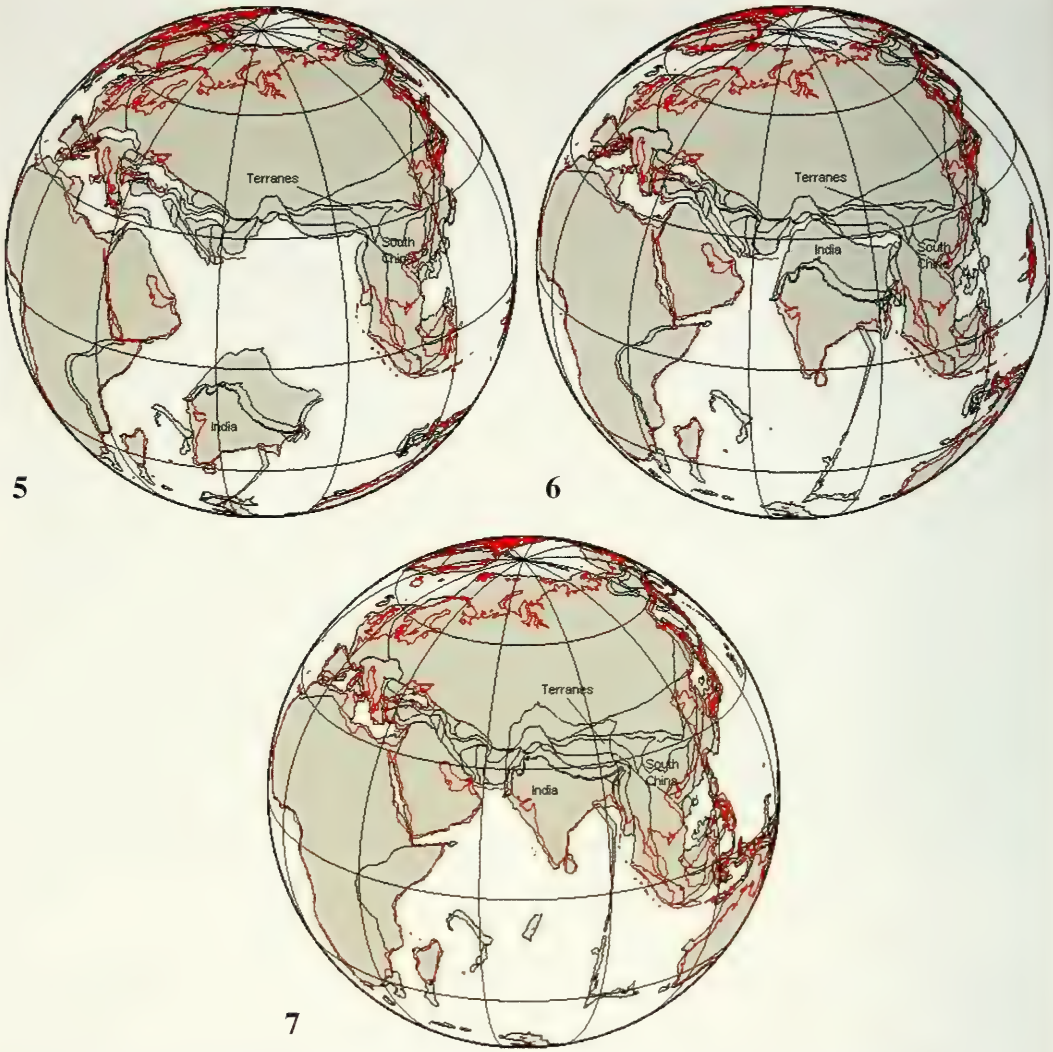
The very earliest collision involved the subduction of plate fragments (blocks or terranes), including the Southern China Block, which were driven north and eastwards by the Philippine/Pacific Plates after they broke away from Pangea and Gondwana. These older movements underlie the eastern part of the Hengduan Mountains in northern Sichuan and their extension along the Longmen Mountains. From the initial breakup of Pangea, in the early Carboniferous between 350 to 300 Mya, the South China Block was always slightly ahead of the Indochina Block as both moved northwards. Nonetheless, the two were always closely associated. The Southern China Block contacted the Eurasian Plate shortly after the Northern China Plate and before the Indochina Block; this happened as early as 200 Mya.

The Southern Terranes separated from the Northern Terranes very early, around 300 Mya. The sub-plate of the Southern Terranes broke away from Pangea much later than did the previously mentioned Plates and Blocks (South China, Indochina, and Northern Terranes). The Northern Terranes impacted the Eurasian Plate to the northwest of the South China Block. The Lhasa Terrane forms part of the GLGS and it belongs to the Northern Terrane group. The Southern Terranes managed to catch up with the Lhasa and Northern Terranes as they were slowed by collision into the Eurasian Plate. By 100 Mya, the Southern Terranes were abutting the Northern Terranes, on the south side of the Eurasian Plate and were adjoining the west side of the Hengduan Mountains. These plates can be seen in Figure 5 at 65 Mya and are already in place at that time. Figures 5–7 were produced using the web service of the Ocean Drilling Stratigraphic Network Plate Tectonic Reconstruction Service (Soeding 2004), and the general discussion follows maps produced at the History of Global Plate Motions (Dutch 1998, citing data from Scotese 1994). The Hengduan Mountains are, thus, the result of these collisions. Formerly, the upper GLGS region would have been influenced by these early tectonic movements and collisions. However, in the GLGS, any early signal has now mostly been overwritten by subsequent events.

Cenozoic Tectonic Movements.— In the early Tertiary, by 55 Mya, both Northern and Southern terrane groups were enclosed by the Indian Plate to the south, the South China Block to the east, and the Eurasian Plate to the north. The closing of the Tethyian seaway north of the GLGS was achieved by the relatively fast collision of the Indian Plate with the Eurasian Plate in the early Cenozoic. Eventually, both Northern and Southern terranes were sandwiched between the Indian Plate and the Eurasian Plate and became extruded and highly deformed (see Fig. 6 at 25 Mya). The present strains on these plates change orientation in the region of the northern GLGS from north-south to east-west (Bi 2004).

The Indian Plate moves north by as much as 50 mm per year, and the area has absorbed some 1500 km of deformation since first contact between India and Eurasia (Replumaz et al. 2004). In Myanmar, the amount of annual movement is only 35 mm (Socquet and Pubellier 2003). The crustal thickness over the Tibetan Plateau is much greater than elsewhere. Remnants of ocean crust lie now just west of the GLGS in Assam and can be seen as the white patch in Figure 7. The terranes can be seen as thin strips sandwiched in between the larger plates. The congregation of plates in the region of the Hengduan Mountains can clearly be seen in Figure 7.

As a consequence of the Indian Plate's collision into the Eurasian Plate, the eastern Himalaya syntaxis rotated clockwise, and crustal fragments of the Northern and Southern Terranes extruded southeastward. The extrusion was along the NW-trending Karakoram-Jiali, N-trending Gaoligong Shan, and Sagaing Faults (Lin et al. 2004). Ages of the faults indicate that deformation may have started from the south along the Sagaing Fault in Indochina and propagated toward the north along the Gaoligong Shan Fault. Subsequently, the deformation proceeded toward the northwest along the Jiali Fault and then the Karakoram Fault in southern Tibet. Such a deformation trend reflects continuous deformation caused by the northward indentation of the Indian Plate into the Eurasian



FIGURES 5–7. (5): Reconstruction of Plate movements for 65 Mya; (6): at 25 Mya; (7): present. Present coastline is shown in red on the grey plates. White indicates sea floor. Images courtesy of Soeding (2004).

Plate, which has continued during the whole of the Tertiary (Lin et al. 2004).

The Hengduan Mountains are bound by a series of north-and-northwest-striking Cenozoic faults: to the west by the Gaoligong Shan and Batang-Lijiang strike-slip systems, to the east by the Longmen Mountain thrust belt and the Xiaojiang Fault, and to the south by the Red River fault shear zone (Wang et al. 2001). The Cenozoic deformational history of the eastern Indo-Asian collision zone may be divided into three stages: (1) Eocene-Oligocene (40–24 Myr) transpression in eastern Tibet starting in the Red River Shear Zone just below the GLGS; (2) early-middle Miocene (24–17 Myr) transtension in eastern Tibet; and (3) late Neogene-Quaternary east-west extension, widespread in eastern Tibet and Indochina, which created small basins to the east, west and south of the GLGS (Wang et al. 2001).

Quaternary Tectonic Movements.— The newest tectonic arrival, the Australasian Plate,

has driven the Indochina Block northwards, crushing and distorting the latter's northern front. The Indochina Block is highly deformed in the north but behaves approximately like a rigid block in the south (Wang et al. 2001). Secondary thrusting in the area is now active in the south of the GLGS as a result of the Australasian Plate subducting beneath Indonesia. For example, in Pupiao—a basin adjoining the GLGS along the east bank of the Nujiang River in Baoshan County—the Miocene/Pliocene soft coal beds are uplifted 70 m and tilted so that the adit entrance is at 60 degrees (pers. obs.).

The latest area to deform is south of the GLGS at the point where the Nujiang River first heads east, then south, and then southwest. The river courses of the Nanding River to the south of the study area, the Dayang, Wanding, and Longchuan Rivers run along associated en echelon faults in a newly established rupture zone. In addition, the Nujiang River is strongly diverted westwards by them. This zone of active faults dates from the Early Pleistocene. The ENE-WSW trending Longling-Lancang fault zone cuts across the earlier tectonics during the later period (Guo et al. 2000). This extensional drag possibly resulted from the orthogonal friction of the Indian Plate moving north along the middle of Myanmar (Socquet and Pubellier 2003) or from the Australasian Plate's impact along Sumatra and the Andaman Islands. The Tengchong region also exhibits a series of N-S faults, which contain the upper reaches of the Daying, Longchuan and Mingguan Rivers.

Tectonics and Mountain Building in the Gaoligong Shan.— The Paleozoic and Mesozoic Era plate movements resulted in faulting, folding, and the formation of metamorphic rocks and magmatite. These tectonic features were formed in the Paleozoic Era with the breakup of Pangea. The same trends continued with added impetus throughout the Mesozoic as the plates assembled on the south side of the Eurasian Plate. Then, in the Cenozoic, the extensive regional fault system was activated as a result of the collision of the Indian Plate with the Eurasian Plate, and a collage of terranes and other plate fragments. The complex tectonics of the GLGS region has resulted in extensive orogeny and erosion. It has also resulted in volcanism, extensive metamorphism, and local eruptions. And, in the GLGS, it has resulted in the uplift and exposure of rocks of much older periods. The movements of the tectonic plates and reentrant terranes were facilitated through a series of large strike-slip faults, as mentioned above. The courses of the Nujiang River, Lancang River, the northern part of the Jingsha River, and the Red River to the south, flow in these very large fault structures. The main branch of the Irrawadi River follows in the the course of another set of faults zones further to the west. The rivers have been entrained by the uplift, but, because of their huge watersheds, their large flows were sufficient to keep pace with the uplift through their down-cutting action. The Nujiang River Gorge Fault facilitates some 17 mm of slip per year along the Yunnan River Valley fault system (Socquet and Pubellier 2003), a fact highly relevant to the dams planned for the area. The constitution, trending, and formation period of the compressional, north-south older tectonics are totally different from those of east-west extensional tectonic active in the Longling-Lancang Rupture Zone that formed in the Pleistocene.

Earthquakes.— As a result of extensive and ongoing tectonic activity in the Hengduan Mountains, it is an active fault zone with many earthquakes (Meyerhoff et al. 1991). To the east of the Hengduan Mountains, along a line from the Longmen Mountains to east of the Lancang River, is an active zone of large earthquakes that have registered eight and above on the Richter Scale. The Nujiang River Fault, Lancang Fault, and the Red River Rupture Zone, are strike-slip faults that register earthquake magnitudes of typically less than eight and rarely above seven. In contrast, the Yarlung Zangbo (Brahmaputra) Fault Zone, which encompasses a system of low-angle thrust faults, experiences larger earthquakes, ones that often register over eight. Strike-slip faults rupture at lower magnitudes than do thrust faults, which are usually associated with subduction boundaries.

At first, the axis of the zone of thrust faults seems to have been in Longmen Mountains but moved west to the Nujiang River in the Permian and now is along the Yarlung Zangbo fault system (Meyerhoff et al. 1991). Currently, the main thrusting activity has moved south from the Yarlung Zangbo to the Frontal and Main Boundary Thrust systems in northern India and Nepal. Large earthquakes have the potential for tectonic damming of the rivers, that is major slides that often result from earthquakes generated by fault movement. For example, this happened on the Yi'ong Zangbo River just northwest of the GLGS. There a 33-km^{-2} lake formed behind a 2500 m by 60 m high dam in 2000. The dam subsequently failed, which resulted a catastrophic flood of over 100 km in length. Evidence of such damming, and scouring floods should be visible in the river terraces if they have occurred on the Nujiang River.

Biodiversity Implications of Tectonics.— The paleo-separation and subsequent reaggregation of plates from Gondwana and their eventual collision with the Eurasian Plate brought diverse biotas together from different paleo-continents. The area's complex uplift history has fostered greater genetic diversity in the region because of complex patterns of exchange, isolation, adaptation, extinctions, and speciation. Of particular importance has been geographic division due to the tectonically-driven incision of the landmass by massive rivers that has given rise to opportunities for vicariant events leading to further diversification. Tectonic activity has implications for the evolution of diverse host rock and soil types (see below).

Geology

Geological Province Overview.— The geologic provinces of the GLGS broadly agree with the boundaries of their tectonic elements. The GLGS contain three geological provinces: (1) the Lhasa Terrane from the Northern Terrane Group, which extends from the north along the Nujiang River valley to 70 kms south of Fugong Town; (2) the Himalaya Block of the Southern Terrane Group in the northwest near the Dulong River and south to near Gongshan Town; and (3) the Tenasserim-Shan Block of the Indochina Block, which includes all of the middle and southern GLGS. The Qintang Terrane forms the eastern border to the GLGS, but it is seen within only a tiny portion of the study area near Lishadi Village just north of Fugong Town, (see Figs. 2, 8). Each province has a set of geologic characteristics that distinguishes it from surrounding provinces. These characteristics may include the predominant lithologies, the age of the strata, and the structural style (Steinshouer et al. 1997; Wandrey and Law 1997).

Age of the Rocks of the Gaoligong Shan.— The Paleozoic Era GLGS formations are dominated by fault-, fold-, metamorphic-, and magmatite-deformed rocks. The major outcropping of Mesozoic Era rocks is more to the east of the study area along the Qintang Terrane; the rocks have been uplifted and folded, accompanied by compressional foreshortening, giving rise to the Nushan Mountains. However, smaller outcrops of Mesozoic rocks occur at both ends of the study zone (Fig. 9). To the southeast and generally along the western edge are large areas of Precambrian-age metamorphic rocks. Further to the west in the modern Burmese Basin (Myanmar), the Precambrian is overlain by Tertiary and Quaternary sediments. Many sedimentary strata in the GLGS have been lifted to being nearly vertical. The whole southern Hengduan Mountains area underwent more folding and uplift throughout the Cenozoic Era. This high degree of folding led in the southern GLGS to the exposure of older Lower Paleozoic sequences, some as early as Cambrian. Cenozoic rocks in the GLGS include further metamorphic changes to host rocks and, locally, volcanism around Tengchong Town, in the southwest and west of the GLGS in Myanmar probably reflect extensional tectonics as a result of ongoing subduction of the eastern limb of the Indian plate. Both Tertiary and Quaternary volcanics and sediments have formed in Tengchong

County. During the Cenozoic, a series of extensional basins formed and can be seen as small patches around the GLGS in Figure 9. These basins are associated with the change in thrust direction in the Plio-Pleistocene. Recent geological deposits consist of considerable scree and colluvium, alluvium, flood facies, and river terracing that can be seen in a few places in the river valleys. In the extreme north of the GLGS, there are extensive glaciers and paleoglacial features. The glaciers are shrinking at an astonishing rate, as can be seen when comparing recent satellite photographs with photos taken in the 1970s; this is probably as a result of global warming.

Generalized Geology

Starting from the north, the geology of the GLGS will be examined in more detail and briefly discussed, because geology has an impact on present landforms and implications for biodiversity. The data are taken from two USGS open-file reports for Far East Asia and South Asia, respectively (Steinshouer et al. 1997; Wandrey and Law 1997). The maps presented in this paper that were derived from these data are not accurate beyond 1 km and the discussion is of regional overview or generalized geologies only.

Lhasa Terrane.— The Lhasa Terrane comprises the north of the GLGS area, in eastern Chayu County (Zayü Xian) and the southern part of Zougong County (Zogang Xian) of the Tibetan Autonomous Region (Xizang Zizhiqu). The Lhasa Terrane also forms the northwestern part of Gongshan Dulong-Nu Autonomous County of Yunnan Province (Gongshan Drungzu-Nuzu Zizhixian) (referred to herewith as Gongshan County). The Lhasa Terrane is formed into a high mountainous area of Upper Paleozoic Rocks (PZu) (Figure 10). The Upper Paleozoic Rocks in general within the GLGS consist of intercalated beds of carbonate, argillaceous deposits, basalts, and metamorphosed rocks with the upper facies containing more volcanics. The Lhasa Terrane is flanked to the northwest (north of the Dulong

FIGURE 8. Map of the Geological Provinces within the Gaoligong Shan; these provinces broadly agree with the positions of tectonic plates (data from Steinshouer et al. 1997, Wandrey and Law 1997).

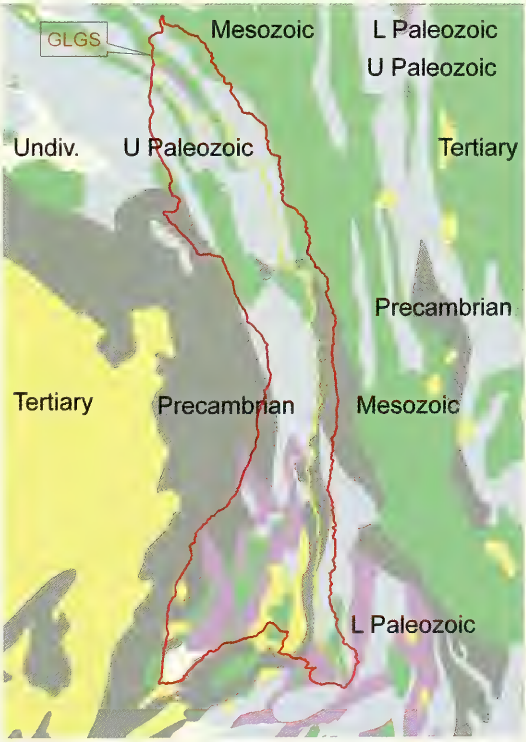


FIGURE 9. Geologic Map of the Gaoligong Shan showing the geologic age of the strata.

River) by Jurassic- Cretaceous (JK) age sequences. These sequences occur to the east where beds of Jurassic-Cretaceous age form the course of the Nujiang River. In the finger of the terrane extruded towards the town of Fugong, the river cuts through the Triassic (Tr) beds of the Lhasa or Qintang Terrane. Beyond, the Nujiang River reaches the Precambrian (pC) beds, which consist of some paratethys and some metamorphic and basaltic rocks. These Precambrian rocks form most of the ridge of the GLGS. The Precambrian metamorphics also form the ridges in the extreme west of Gongshan County and part of the ridge of the Patkai Range. The Patkai Range and other ridges in Myanmar are not part of the GLGS and lie outside of the study zone. Small patches of these Precambrian rocks are also exposed at the junction of the Himalaya Block, Lhasa Terrane, and the Tenasserim-Shan Block near to the town of Gongshan.

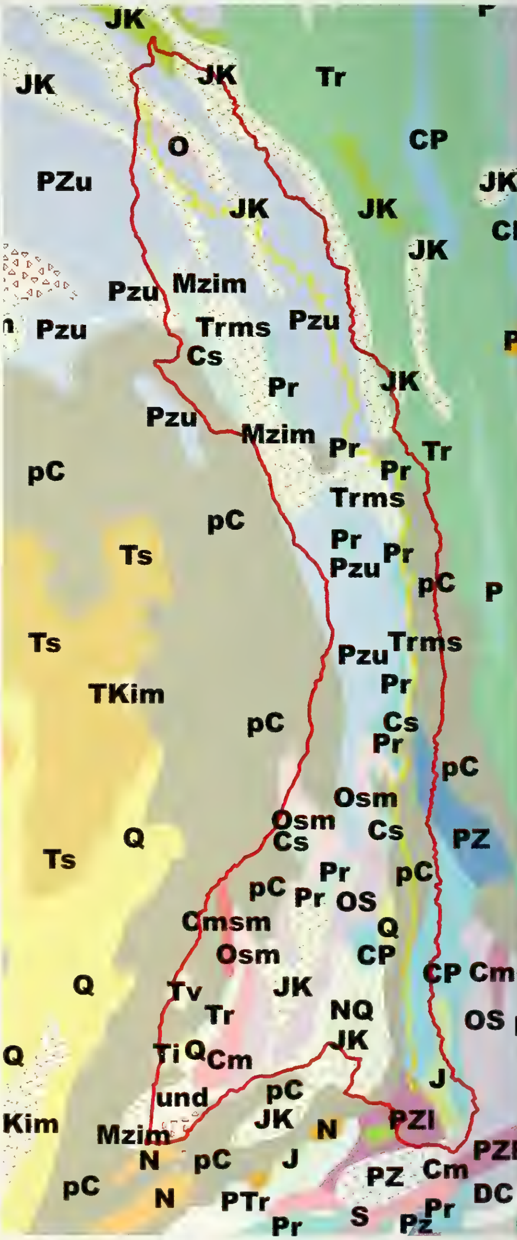


FIGURE 10. Map showing the geologic units in the Gaoligong Shan.

HIMALAYAN BLOCK.— The Himalayan Block forms the southwest of Zayü County and forms all of the eastern part of Gongshan County west of the Dulong River watershed. The mountains of the Himalaya Block are lower than those of the Lhasa Terrane. The Himalayan Block is formed mostly of Mesozoic intrusive and metamorphic rocks (Mzim). The Himalayan Block also extends across the northern end of the Tenasserim-Shan Block to form the finger that is caught between the Tenasserim-Shan Block and the Lhasa Terrane. This finger is formed of Triassic metamorphic and sedimentary rocks (Trms), possibly a shallow sea ophiolitic melange. To the west, mostly outside of the study area, in the northwest corner of Gongshan County, there are extensive areas of Precambrian (pC) rocks belonging to the Himalaya Block. Between these and the metamorphic core of the Himalaya Block in Gongshan County is a flank of Carboniferous sedimentary rocks (Cs). On the other flank, between the westerly edge of the Himalaya Block and the Lhasa Terrane, are small outcroppings of Permian sedimentary rocks, probably consisting of deep-water turbidites (Meyerhoff et al. 1991).

TENASSERIM-SHAN BLOCK.— MAIN RIDGE OF THE GAOLIGONG SHAN IN FUGONG, LUSHUI, AND KACHIN.— The majority of the GLGS sits on the Tenasserim-Shan Block. The middle reach-

es of the GLGS comprise Fugong and Lushui Counties and to the west, Kachin State of Myanmar. The middle reaches of the GLGS ridge are in the northern part of the Tenasserim-Shan Block that extends south from the border with Gongshan County and the Himalaya Block. The GLGS main ridgeline skirts around the northern edge of Triassic metamorphic and sedimentary rocks (Trms) and runs south through the middle reaches between Precambrian (pC) on the east and Permian (Pr) and more Triassic metamorphic and sedimentary rocks (Trms). The Permian beds have more Tethyian affinities. To the west, the middle reaches of the GLGS are formed of Upper Paleozoic rocks (PZU). The actual ridge and the eastern flank of the GLGS are formed of Precambrian (pC) rocks. Small Carboniferous sedimentary (Cs) bodies pop out in the southern part of the middle section together with a larger Ordovician sedimentary outcrop, mostly grapholitic shales and metamorphic rocks (Osm), probably composed of flysch and paraflysch. At the southern end of the middle section, in Lushui County, occurs the end of the highest peaks where the ridgeline is above 3500m.

Tenasserim-Shan Block: Main Ridge of the Gaoligong Shan in Baoshan Prefecture.— In the whole of the southern part of the GLGS, the main ridgeline is in Baoshan Prefecture. To the east of the main Ridgeline, the rocks are mostly Precambrian (pC). There are also outcrops of undifferentiated Paleozoic age of in northern Baoshan Prefecture; south of these are rocks of Carboniferous and Permian (CP) age. Around Daxue Mountain in Longling County in the south of Baoshan Prefecture, there are Lower Paleozoic rocks (PZl). At the eastern foot of Daxueshan at the southern extremity of the GLGS main ridgeline, in southeastern Longling County, is a Jurassic (Jr) intrusion. The Nujiang River flows east of this in a Silurian and Ordovician (SO) region between Longling and Shidian Counties. The western slope from the main GLGS ridge in Tengchong County down to the height of the Tengchong Basin is again Precambrian (pC) south to the Longchuan River. To the south of the Longchuan River in Longling County, the western and southern slopes of the main GLGS ridge are Lower Paleozoic rocks (PZl).

Tenasserim-Shan Block: "NE-SW Trending Ridges" of Myanmar, and the counties of Tengchong and Longjiang.— Because these ridges do not have a collective name, hereafter I will refer to them as the "NE-SW Trending Ridges." Between Lushui and Tengchong Counties, the border of China moves away from the GLGS main ridgeline into Myanmar along a line of high "NE-SW Trending Ridges." These ridges extend from Lushui County Line near Lushui Town towards Jiangao Mountain and continue further for 140 kms into Yingjiang County. The tectonic influences in the southern part and to the west are considerably younger, and have a tighter fold and fault structure imposed on the area. In the Myanmar part of the GLGS, there has been less uplift. Below Lushui County, the rock types become numerous, with smaller outcroppings. In the southern part of the GLGS south of Lushui County, there are similar sequence motifs between the western branch of "NE-SW Trending Ridges" and the eastern branch of the GLGS main mountain ridge, although the rock sequences are not identical.

The westernmost flank of the "NE-SW Trending Ridges" is composed of rocks of Precambrian (pC) age. North of Tengchong County in Myanmar are Ordovician sedimentary and metamorphic (Osm) rocks, and southwest of these are more Carboniferous sedimentary (Cs) rocks. The Precambrian rocks return to be replaced further southwest by a small body of Cambrian (Cmsm) sediments and metasediments. Next to these Cambrian beds are more Ordovician sedimentary and metamorphic (Osm) rocks. The Precambrian makes up the south-westernmost corner of the GLGS ridges, except for inclusions of various igneous rocks. These parts of the "NE-SW Trending Ridges" are all in the Myanmar part of the GLGS.

The eastern flank of the "NE-SW Trending Ridges" in northern Tengchong County is Ordovician/Silurian (OS) and Permian (Pr). In western Tengchong and Yingjiang Counties, the

eastern slopes of the "NE-SW Trending Ridges" are composed of Jurassic, Cretaceous, Triassic and other undifferentiated Mesozoic igneous rocks. West of these are small outcroppings of Tertiary volcanics, namely basaltic flows, andesitic lavas and pyroclastics, which overlie the Precambrian (pC) rocks that form the ridges of the "NE-SW Trending Ridges" in Myanmar. Just south of this, and slightly to the east in Yingjiang County, is an outcrop of Triassic (Tr) rocks along the border between Yunnan and Myanmar and the east flank of the "NE-SW Trending Ridges."

Tenasserim-Shan Block: Central Basin Area of Yingjiang, Longchuan, and Tengchong Counties.— The area between the eastern flank of the "NE-SW Trending Ridges" and the western flank of the main ridgeline of the GLGS is a raised area dissected by the Daying and Longchuan Rivers and their tributaries. Running NE-SW down the middle of the area is a spine of Ordovician Silurian rocks that separates the drainage of the two rivers. There is a series of N-S to NE-SW trending faults that split the central area of Tengchong County from the "NE-SW Trending Ridges" down to the Longchuan River. These open up the Tengchong Basin into a "fan - folded" series of mountainous ridges. The upper headwaters of the Dayang and Longchuan Rivers and their tributaries like the Mingguan River run along these fault lines. These can be best seen in Figure 10.

To the east of the Triassic igneous rocks, which occur along the border with Myanmar, there are Cambrian (Cm) and Silurian and Ordovician (SO) rocks, which extend towards the Longchuan River. To the east of the Longchuan River and north to the region of Tengchong Town, the area is mostly filled with Mesozoic beds of Jurassic-Cretaceous (JK) age, although these are extensively overlain by Neogene and Quaternary volcanic deposits and some younger volcanically-derived sediments. Tengchong County is characterized by a horseshoe-shaped opening to the south composed of Neogene sediments surrounding the Jurassic-Cretaceous mountains. The central region of Tengchong and eastern Yingjiang Counties is probably a zone of extension along the *en echelon* fault system that extends from here and further south. These younger faults cut across the older tectonic imprint (Guo et al. 2000). This extension would have exposed different rocks, as well as having allowed infilling by volcanic activity and for sedimentation to have taken place. These form the Quaternary Tengchong Basin, which appears to have subsequently uplifted. The Tengchong County pyroclastic cone field is not shown on Figure 10. It covers 600 km^{-2} and has erupted in five phases since the Tertiary. The nature of the eruption has changed from andesitic lavas in the early Tertiary to olivine-rich basalt lavas during the Pliocene through to the present. Daying Mountain Crater, 2865 m at 25.32°N, 98.47°E, last erupted in 1609 in an explosive eruption (Smithsonian 2005). The many preserved cones in this area could be a source of local adaptation and vicariant speciation of smaller organisms.

Soils

The heterogeneity of soils in the GLGS is a consequence of the region's geologic diversity. The variety of host rocks, of very different ages, has given rise to many soil types. Although the remotely sensed data for this region are rather coarse (1:4 M), some different dominant soil types are observable (F.A.O. 2005). The existence of many host rocks with different suites of predominant minerals and a multitude of microclimates ensure a much greater diversity of soils on the ground than has been actually mapped. Within the study area, there exists a variety of soils with pH that varies from limestone-derived alkali types to acidic ones.

In the north, on the Himalaya Block, are found the following lithosoils, humic cambisol, and eutric cambisol west of the Dulong. From the Lhasa Terrane in the north along the entire eastern slope and ridge of the GLGS are calcaric fluvisols. The western slope from the northern to the northwestern part of Tengchong County has lithosoil and humic cambisol. These continue south

from Tengchong County along the western slope of the main GLGS ridge. In southwestern Tengchong and northern Yingjiang Counties are orthic acrisols. A tongue between them, from the central part of Tengchong County south until the Longling County border, is composed of ferric acrisol. The very southern portion of the study area in Longling County exhibits a more developed orthic acrisol (F.A.O. 2005). The predominant agricultural soil types seem to be latosols, laterite, red earths, yellow earths, purple earth, and paddy soils (F.A.O. 2005). These are mostly alluvial terraces derived from the material of calcareous sedimentary rock, although the orthic acrisols are more acidic (F.A.O. 2005).

Soils evolve according to the latitude, elevation, temperature, and rainfall regime in which they are distributed. The same host rock minerals will give rise to different soils depending on the environment. Soil diversity, in turn, gives rise to floristic diversity and, ultimately, is another source of biodiversity. The soils at the two ends of the GLGS range are quite different. The great range of host rocks, elevation, latitude, and monsoon conditions within the GLGS gives rise to considerable soil diversity, hence contributing to the region's biodiversity.

Hypsography and Landform Analysis

The size of physical geographic structures in the Hengduan Mountains is large and the component ranges or ridges can extend hundreds of kilometers. The GLGS are the most southerly reaching of the major ranges. Each range can have many names where it crosses ethnic boundaries. These names will be given from north to south and will be abbreviated to that shown in brackets. (1) the most easterly transverse ridge being the Ninjingshan-Yunling-Qingshuilangshan (Yunling Mountains), which form the eastern bank of the Lancang River; (2) between the Lancang and the Nujiang Rivers is the Taniantawenshan-Nushan Ridge (Nushan Mountains); and (3) the most westerly ridges of the Hengduan Mountains are the GLGS, with the "NE-SW Trending Ridges" of Jiangao Mountain extending into the Kachin State of Myanmar. The Shanngwa Range west of the Nmai and Tamai Nmai Rivers is not considered part of the Hengduan Mountains. Neither is the next ridge beyond the Mali River, the Kumon Range. The transverse ridge joining these Myanmar ranges in the north (the Patkai Mun Range between upper Myanmar and Assam) is not part of the GLGS.

Northern Limit of Gaoligong Shan.— The upper GLGS are separated from the eastern Himalayas by a major tributary of the Yarlung Zangbo River (Brahmaputra), the San Qu River (Luhit River in Assam, also known as the Sang Qu and Zayü Qu River further north). This tributary extends as far as the Zayü County and Zogang County border. A few kilometers to the north of the Zayü Qu rise the Parlung River and Yi'ong Zangbo River, other tributaries of the Yarlung Zangbo River (Brahmaputra). North of this area, the Nushan Mountains loop over the northern end of the GLGS. The most southerly of the mountain ranges of the Tibetan Plateau, the Nyainqetanglashan, are just north of the Yarlung Zangbo River (Brahmaputra). These are separated from the GLGS by a river that is a tributary of the Nujiang River to the east. This tributary almost joins the drainage of the Parlung and Yi'ong Zangbo Rivers south of Bomi Town to the upper course of the Sang Qu River (Luhit). These mark the northwestern river boundary of the GLGS. Together they form a high valley between the Nyainqetanglashan and the GLGS, near Baxoi Town, well south of Qamdo. At Baxoi Town, the most southerly road from Sichuan Province and Lijiang City, Yunnan passes into eastern Zayü County towards towns of Gyigang and Zayü. This is just north of the Diphu Pass above the headwaters of the Tamai Nmai River. The Diphu Pass marks the boundary of the Patkai Range and the GLGS. All these structures combine to make a break in the GLGS that clearly separate it from its higher neighbors. Many of the peaks in the upper

Nushan Mountains and eastern Himalaya are 7000 m plus. These physical features can be seen in the elevation perspective model (see Figs. 11–13 and the satellite image, Fig. 14).

Southern Limit of Gaoligong Shan.— The southern boundary of the GLGS is clearly defined. The GLGS end where the main ridge ends in an encirclement by the Nujiang River to the east, south and west, and its tributary the Supa River. The Supa River rises off the northwest side of the main GLGS ridge on Daxue Mountain- near the village of Zhen'an. The Supa River runs northeast of the city of Longling to join the Nujiang River north of Pingda. This tributary is almost met by the Mangshi River, a tributary of the Longchuan and Irrawadi Rivers, which rises just southwest of Longling Town. To the west of this promontory are the NNE-SSW ridges of the low mountains within Luxi County that meet the GLGS ridge just north of Longling Town. These are separated from the GLGS by a saddle between the aforementioned rivers. These physical features can be seen in the elevation perspective model (Figs. 15–17) and satellite image (Fig. 18).

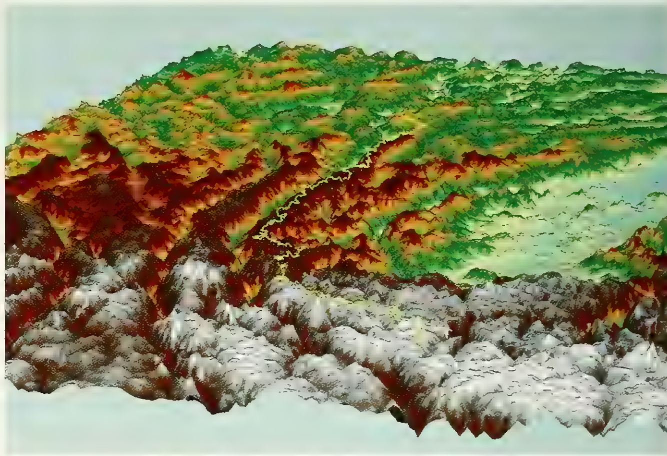


Figure 11. Perspective view of the Gaoligong Shan from the north looking towards the southeast. Main ridgeline shown as a yellow line.

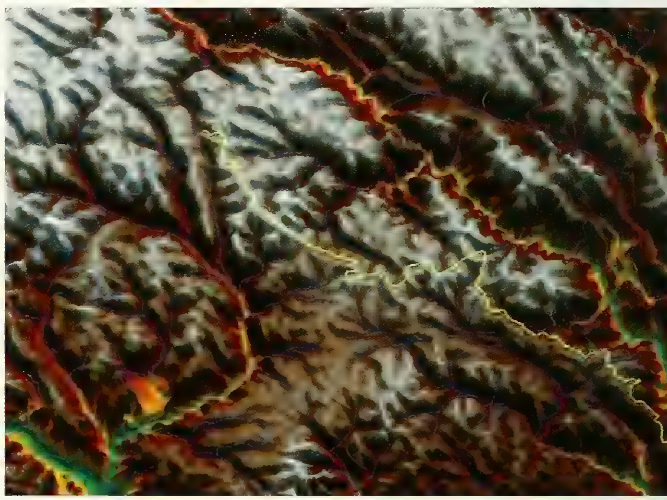


Figure 12. Close-up perspective view of the northernmost Gaoligong Shan (GLGS) looking from the west looking northeast, note the valley of the Luhit-Sang Qu incising into the GLGS and forming a near connection of the Luhit-Sang Qu-Parlung Zangbo and Nujiang drainages. Main ridgeline shown as a yellow line.

Land Form of Gaoligong Shan.— The elevational nature of physical features is the result of the interplay between tectonic, geologic, and natural erosional forces. High mountains are formed by tectonics and are maintained either by hard rocks and slow erosion, ongoing tectonic actions, or both. Harder rocks make for steeper slopes and more bare outcrops. Rain, wind, and ice work together with gravity to reverse tectonic uplift. The steep mountains in this area result from ongoing uplift, and the hard nature of their rock. Despite the fact that rainfall in the area is considerable and biotic productivity high, soil formation and rock decomposition are unable to wear down the mountains fast enough.

As noted above, the majority of high ground is formed from the Precambrian rocks, mostly metamorphics. The main ridge of the GLGS runs due N-S and is composed primarily of these

rocks. To the east of the ridge is the Gaoligong Shan Fault, which forms the bed of the Nujiang River (see Fig. 4). The action of the fault causes enough brecciation and mylenation of the country rock to enable the river to carve a gorge that is thousands of meters deep and form a non-glacial "U-Shaped" valley. The easterly side of the Nujiang River is the Qintang Terrane composed of primarily younger rock. It also has a large fault structure river complex along the course of the Lancang River (see Figs. 3–4).

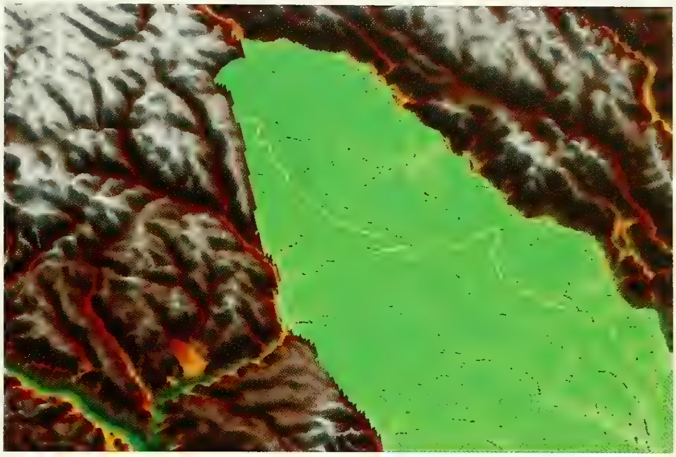


FIGURE 13. Close-up perspective view of the northernmost Gaoligong Shan, showing the area included in the GLGS in green. Main ridgeline shown as a yellow line.

The non-glacial "U-Shaped" valley of the Nujiang River is formed by uplift. The land is currently being uplifted more in the west. This forces the river towards its east bank and hence undercuts it, thus, widening the valley floor. On the western bank in many places can be seen a bench that forms about halfway down from the ridge (personal observation, but it also can be seen on the elevation models; this bench is just visible in Fig. 15.). Most of the roads and towns of the Nujiang River valley are located on this bench and on the western bank in general.

FIGURE 14. Space Imagery, taken looking ENE along the Luhit-Zayü and Sang Qu Rivers towards the Nujiang. Note the treeline at the headwaters of the Dulong in the south (right). Image courtesy of the Image Analysis Laboratory, NASA Johnson Space Center (NASA 2004c).

Shape of the Main Gaoligong Shan Ridge.— The mountains of the GLGS and southern Hengduan Mountains in general rise from the south to reach impressive heights in the north. Just north of the GLGS across the Luhit-Zayü Qu-Sang-Qu drainage, is a large glacier field with peaks rising above 5000 m. This glacier is shrinking. The main GLGS ridge changes height from the 3001 m peak of Daxue Mountain Longling County at the southern terminus, down through a small saddle at 1930 m the lowest point of the ridgeline, to rise steadily upwards to 4500 m proceeding north as shown in Figures 19 and 20. The maximum height of any peak in the study area is 6318 m southeast of Zayü County. The course of the Nujiang River by comparison rises only 1500 m from 600 m in the south to around 2100 m towards the north of the study area. Therefore, the depth of the channel is much greater in the north than it is in the south. The valley is more than 3000 m deep at most points in the north and almost always more than 2000 m deep throughout the GLGS.

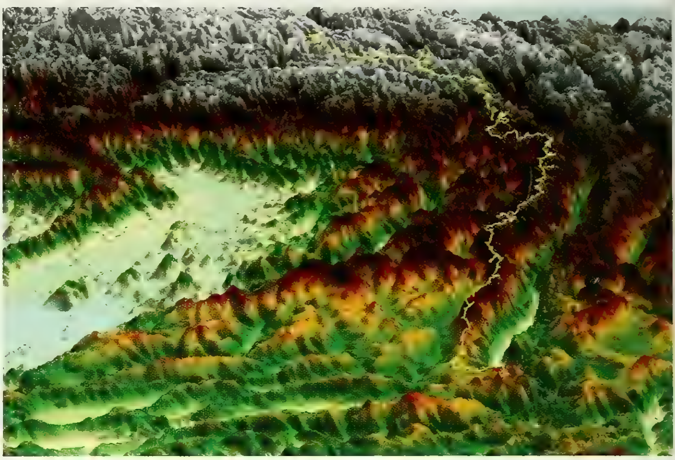


Figure 15. Perspective view from the southeast looking along the drainage of the Nujiang. Main ridgeline shown as a yellow line.

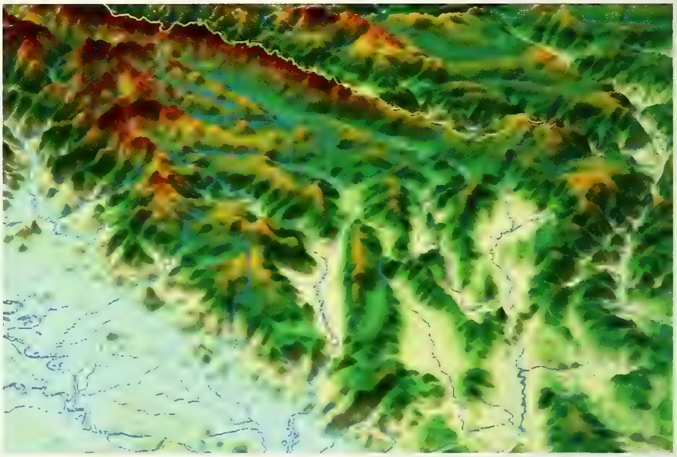


Figure 16. Close-up perspective view of the southernmost Gaoligong Shan, GLGS main ridgeline shown as a yellow line.

The GLGS ridge is traversed by only a few passes. In the south is the pass to Longling County that is the main route to the Myanmar border. Luoshuidong Pass, between Bawan and Tengchong Towns, provides another vehicle route to Myanmar. Pianma Pass is near Lushui Town. Other passes include the E'ga Path just north of Lukiu Town, the Yaping Path north of Fugong Town, and the Dazhu Path a little south of Gongshan town. A full vehicle road has been built through the high Dulong Pass in the north. Lastly, the Zayü County and Zogang County border road from Sichuan to Lhasa forms the northern limit of the GLGS.

Cross-sections through the Gaoligong Shan.— The cross-sectional profiles of the GLGS area were taken from the low point at the easternmost edge of the study area in the west to the Nujiang River in the east. These profiles are remarkable for showing the steep walls of the peaks and deeply incised river valleys. The northernmost profile (Fig. 21) from the Zayü River to the Nujiang River shows uniformly high ground. The cross-section of Bingzhoulou Town,

Gongshan County (Fig. 22) has some interesting features. To the east is the land that is lower in the upper Nmai-Irrawadi Rivers and generally lower across the eastern extreme of the Himalaya Block. The harder rocks of the tectonically deformed Lhasa Terrane stand very high. The Dulong River cuts a swathe through them almost as deep as that of the Nujiang River 's valley on the other side of the main GLGS ridge. To cut this deep, there may be another fault active, although it is not shown on small-scale maps available. The Nujiang River runs in a very deep and steep valley at this point.

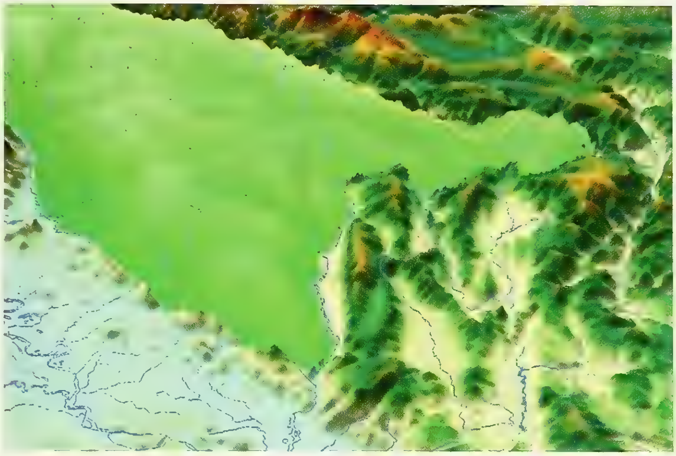


FIGURE 17. Close-up perspective view of the southernmost Gaoligong Shan, showing the study area included in the GLGS in green.

FIGURE 18. Space Imagery, taken looking east along the Longchuan River towards the Gaoligong Shan Ridge. Image courtesy of the Image Analysis Laboratory, NASA Johnson Space Center (NASA 2004b).

The next profile at Lukiu Town (Fig. 23) is across the area where the rocks are more uniform Paleozoic and form the "NE-SW Trending Ridges" that extend towards Jiangao Mountain from the main ridgeline. The main GLGS ridge stands higher and there is little penetration of the rivers that here tend to run either north or south from the "NE-SW Trending Ridges". There is little in the way of river erosion in the mountains here because of their smaller catchment basins. Although the Nujiang River flows in a steeper valley than at its outlet, it is at an elevation little changed from its exit from the GLGS. The most southerly profile, through the top of Tengchong (Fig. 24), is from where the GLGS has been opened by N-S trenches along which flow the Longchuan River to the east and the Dayang River in the West. The southern profile is longer and lower than the rest and shows a series of peaks and

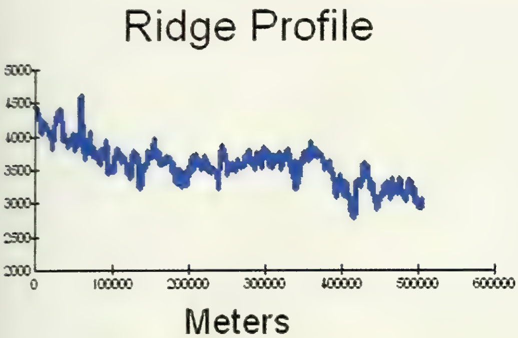
valleys where the tributaries of the Irrawadi River have cut into the Tengchong County region. These rivers also arise within the GLGS so have less volume or down-cutting potential. Uplift in this area is mostly lower than it is further north or it has been reduced by extension. The Nujiang River in the south is at about the same elevation as the Burmese Plain.

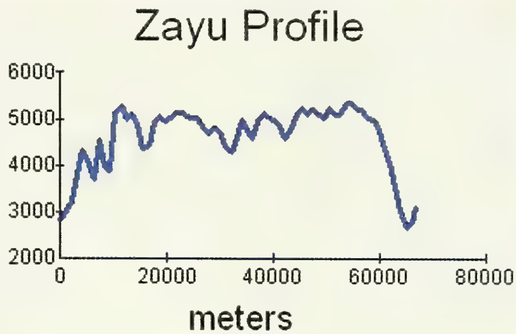
Slope and Slope Direction or Aspect.— What is unusual about the GLGS area profiles is that the deep valleys are cut into rocks able to support steep slopes. The average slope angle for the whole study area is high and is much higher in the north (see Fig. 25). There are very few flat areas of large size in the GLGS.

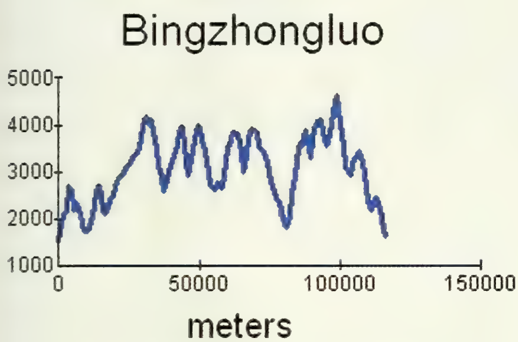
The N-S trending mountains of the main ridge of the GLGS together with the "NE-SW Trending Ridges" in the lower part both have unusual face aspects (see Table 1). Aspect is determined from the average direction that a slope faces relative to the sun. Throughout the study area, there is a paucity of north or south-facing slopes. The east-facing slopes are smaller than those to the west because they are steeper. There are many facing to the west and northwest and then again to the northeast and then east.

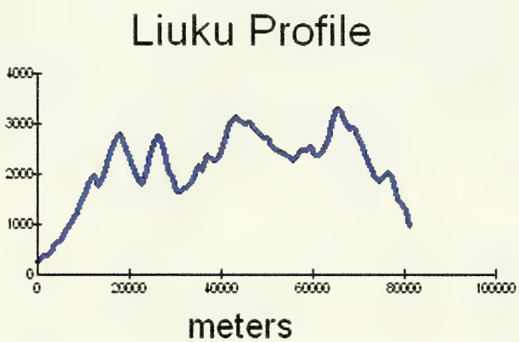
This fact, combined with the angle of the slope, means that many of the surfaces in the GLGS receive lower intensities of insolation relative to an ideal "suntrap." Maximum insolation is received on a slope that is facing south and that is raised to the same azimuth as the sun; in the GLGS this is about 25 degrees. The low energy capture seen in the GLGS is because not much of the energy of the sun is trapped by the slopes that face away from the sun. When the sun shines on a surface that is steeply inclined and angled away from the sun, its energy is dissipated over a much larger area. The steep terrain will also affect the local sunrise, or sunset, or both, especially in a "U-shaped" valley. Therefore, the day length of direct sun, and hence the biotic productivity, will be much curtailed in the steep, "U-Shaped" valley bottoms. These factors produce temperate conditions, which prevail further south in the GLGS than in most places in the world. The magni-

FIGURE 19. Plan of cross sections. See also accompanying figures 21ough 24









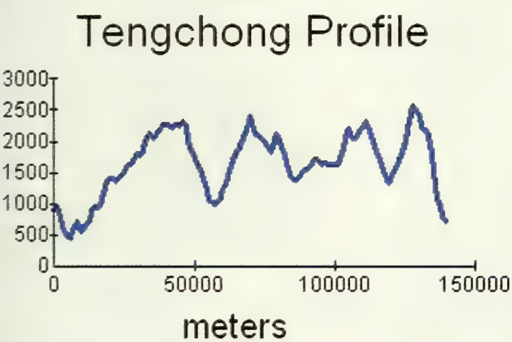


FIGURE 20. Profile of the main Ridgeline.

FIGURE 21. Cross section at Zayü.

FIGURE 22. Cross section at Bingzhongluo.

FIGURE 23. Cross section at Liuku.

FIGURE 24. Cross section at Tengchong.

tude of this effect can be calculated using advanced GIS analysis but this is too detailed to be carried out here.

LANDFORMS AND BIODIVERSITY.— The unusual physical features of the GLGS and their great latitudinal and elevational range provide for the easy maintenance of biodiversity. The north-south conduit enables exchange with the high mountains and plateau to the north. This provides a corridor for temperate animals to migrate southward during harsher conditions. The high elevation equally acts as a barrier for warm-adapted organisms seeking to migrate from west to east or vice versa. The deep, large rivers also act as barriers. The lack of south-facing slopes and the deep valleys combine to make the area relatively more temperate than land at similar latitudes. Cold

TABLE 1. Aspect faces of the GLCS.

Aspect Direction	*Plan Area %*
North	5.5
Northeast	13.0
East	15.5
Southeast	12.7
South	11.2
Southwest	13.5
West	16.8
Northwest	11.8

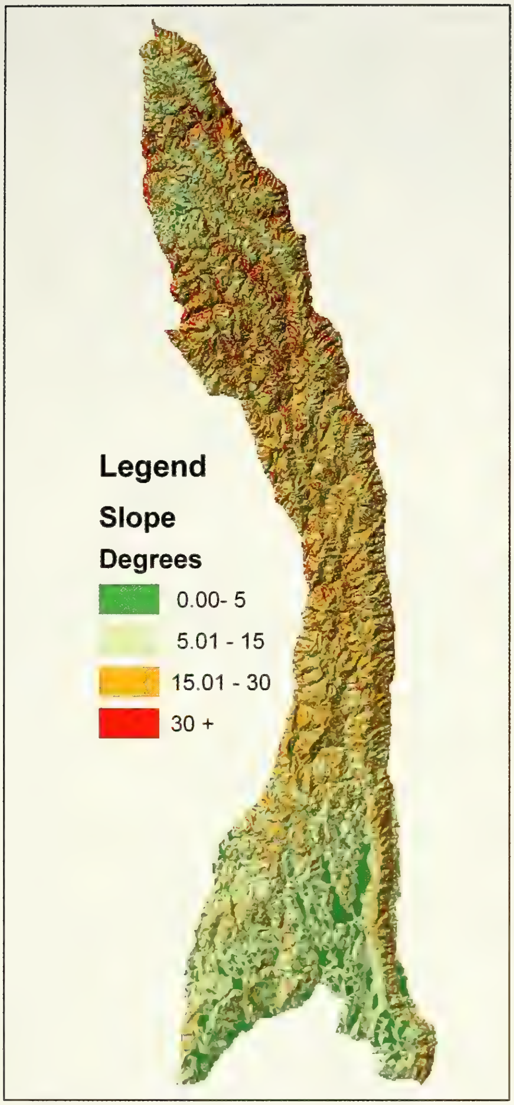


FIGURE 25. The plan view showing the Average Slope of the Gaoligong Shan.

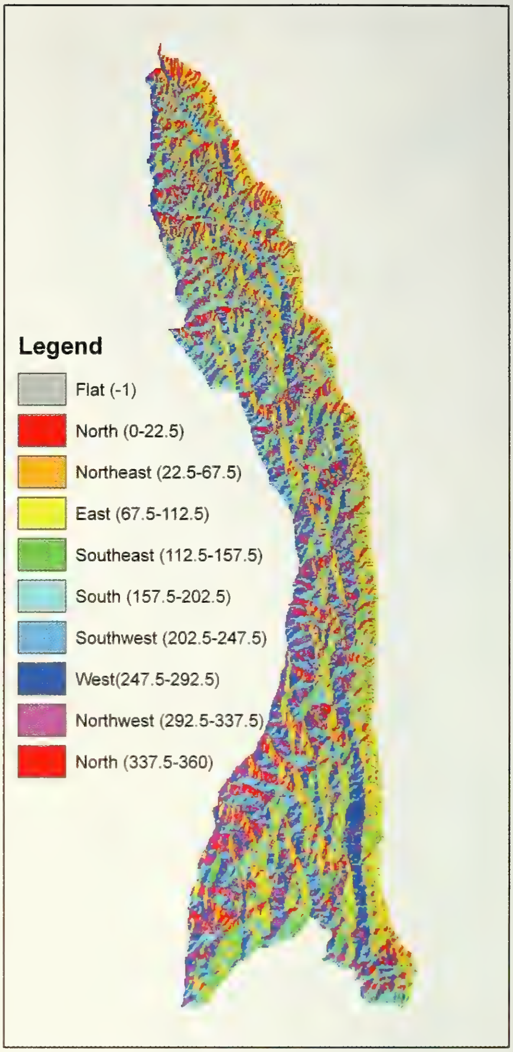


FIGURE 26. The plan view showing the Aspect of the Gaoligong Shan

air can flow into the valleys from high ground surrounding them. These "frost traps" lead to frequent fogs and temperature inversions. The high hills with damp air coming from the west have significant amounts of rainfall on their western slope. These conditions can lead to Foehn heating as damp air is forced over the ridge by the prevailing southwesterly winds. The unusual physical features combine to multiply the number of opportunities for microclimates. Furthermore, these physical features are not fixed in time but are dynamic due to the nature of the underlying geological processes. This dynamism provides ample opportunity for adaptation and vicariant events to further promote biological diversification.

HYDROLOGY

The large N-S flowing rivers of the Hengduan Mountains are of major importance to East and Southeast Asia. The rivers are long, stretching from the Tibetan Plateau to three different seas, the Yellow Sea, the South China Sea, and the Andaman Sea in the Bay of Bengal. Because of their length, each one of the rivers can have many names where they cross ethnic boundaries. These names will be given from north to south and in this paper they will be abbreviated to those shown in brackets, which are their names as used in the GLGS region. These are not necessarily the rivers' more widely used common English names. When using the abbreviated name the intention is for the reader to think of the whole drainage not just that portion in western Yunnan.

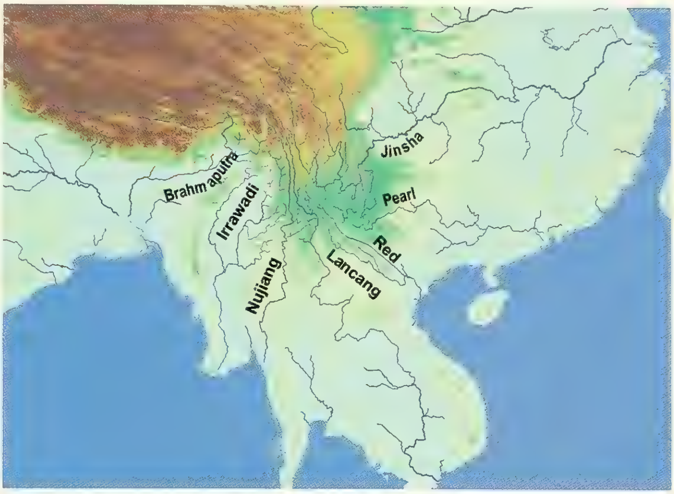


FIGURE 27. Drainage pattern of major rivers through the Hengduan Mountains emphasizing the interdigitated nature of the drainages. Data from Hydro1K (USGS 2000).

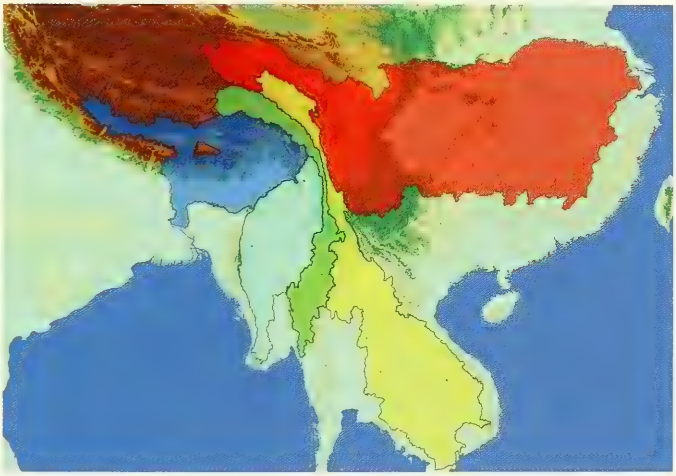


FIGURE 28. The modern drainage catchment basins data from Hydro 1K (USGS 2000).

From east to west the main rivers are the Wulanmulunhe-Muluwusuhe-Tongtianhe-Jinsha-Cang Jiang-Yangtse River (Jinsha River), the Lancang-Mekong River (Lancang River) and the dNgul-chu-Naquehe-Nujiang-Thanlwin-Salween River (Nujiang River). An important tributary of the Nujiang River is the Nanding River, flowing just below the southern end of the GLGS. Starting in China and flowing into Myanmar are the south-southwesterly flowing tributaries of the Irrawadi. They are, from north to south, the Dulong-Taron River joins the Nmai Hka River (Dulong River), Dayang River, Wanding River and Longchuan-Shweli Rivers (Longchuan River). In the southern part of western Yunnan, just to the west of the GLGS, is the source of the Lishehe-Yuanjiang-Hong River (Red River) rising between the Lancang and Jinsha Rivers and its large tributary is the Black River. In the north are the Yarlung Zangbo-Brahmaputra River (Yarlung Zangbo River) and its two easternmost tributaries the Luhit-Zayü Qu-Sang Qu River (Sang Qu River) and the Yi'ong Zangbo River and Parlung Zangbo River. These form the northwest border of the GLGS. They flow to the Bay of Bengal in the west.

It must be strongly stressed that the drainage pattern around the Hengduan Mountains is com-

plexly interleaved. This complicated pattern interdigitates to cause formidable barriers (see Fig. 27). To the north the Yarlung Zangbo River (Brahmaputra)and its easternmost tributaries form a natural barrier. The Yarlung Zangbo River (Brahmaputra) loops in a big bend from flowing east for hundreds of kilometers to turn south, then west, and on to flow southwest to the sea. This loop forms a major obstacle to migration or dispersal. Any migration from the west would be caught in this big bend and would have to back track or go north to get around it. From about the 10 Mya, the climate and ecology to the north would have been very different than that in the big bend area (Jablonski 1998). Today the barrier is complete as the ecology changes from humid tropical to temperate to alpine tundra within a few kilometers along the hills of Arunchal Pradesh. The Jinsha River makes a similar big bend in the opposite direction flowing to the south then east, and then north to turn eventually east again to the Pacific. Between these two, the Yarlung Zangbo (Brahmaputra) and Jinsha Rivers, the following Rivers, Lancang, Nujiang, the Dulong Nmai, and Irrawadi proper, all flow north-south. To the east, starting near the big bend of the Jinsha River is the source of the Red River and to the west of the Red River is its tributary the Black River that runs parallel to it. The Black River rises near to the Lancang River just east of the GLGS. Further east of the source of the Red River is the source of the Pearl River. These form NW-SE river drainages that cut off the approach to the Hengduan Mountains from southern China. The approach from due south to the GLGS (but not the Nushan Mountains) is cut off by the Lancang River and Nanding River and by the eastward flowing section of the Nujiang River. The approach to the Hengduan Mountains from the southwest is blocked by the Nujiang River and the Shweli-Longchuan River, Dayang River and other tributaries of the Irrawadi River. The approach from the west is blocked by the Yarlung Zangbo River (Brahmaputra), Irrawadi River, Tamai Nmai River, and the Dulong Nmai Rivers. West to east migration would be the most difficult because of the need to cross rivers and change elevation across the ridges of western Myanmar. The most isolated of the Hengduan Mountains ranges is the GLGS. The GLGS is highly isolated by its almost contiguous surrounding rivers.

The rivers of the Hengduan Mountains make them exceedingly good biological barriers to terrestrial organisms (Mackinnon et al. 1996). For many terrestrial organisms, migration into the GLGS or dispersion from them is very difficult. Fording the rivers is not easy because they run in very deep, precipitous valleys cut into the mountains. The ridges of the Yunling Mountains, Nushan Mountains, and the GLGS are steep, and traversing them requires agility and considerable environmental adaptability. The steepness of the riverbeds makes the current strong; some of the rivers have dangerous category five rapids. The rivers also carry high volumes of water and experience occasional catastrophic floods.

Biodiversity Implications of the Hydrology Network.— It can be seen from Figure 28 that within the GLGS very little of the area belongs to the Nujiang River watershed. Most of the land area falls within the Irrawadi system. This can be inferred from the ridge profile as well. The Irrawadi is a much newer system than the Nujiang River because it does not drain north of the contact zone with India. A number of factors influence aquatic diversity, including age, temperature, and current.

In the past, these rivers would have been even more of a barrier than are today. The evidence strongly suggest that the larger rivers predate the closing of the Tethys Sea. The present rivers and the paleo-rivers drained regions as far north as the Kunlung Mountains an area north of the paleo-shore of the Tethys Sea.. Before the formation of mountains, there was no rain shadow. The mountains rose in sequential thrust belts developing in the west of the GLGS as the Indian Plate impacted the Eurasian Plate. Therefore, the paleo-rivers would have had to drain the area that is now behind the Himalaya. The area to the north is now in the Himalayan rain shadow. The rain shadow

was absent throughout most of the history of these rivers. Therefore, they would have captured larger volumes of water than the impressive amounts they do today (see Fig. 28). The final uplift of the Himalaya to their current elevations has been in the last 7-3 million years of the 55 million years since India first contacted Eurasia. It was not until after this time that the rain shadow was extensive enough to cause aeolian erosion and loess started to be blown from the rising Tibetan Plateau. The main north-south flowing rivers divide the area biogeographically and socially. The antiquity of the rivers has insured that the areas divided by them accumulated considerable pre-Neogene diversity. Their large size and long length provide opportunity for aquatic diversity to evolve in multiple habitats. The changing levels in the rivers gave rise to fast currents and rough water, which have limited aquatic diversity and prevented migration and dispersal of endemics, while opening the possibility of local adaptation. Their encirclement of the GLGS has created one of the most isolated regions in the world, with a high number of endemic species. Another, biologically significant aspect of the large rivers is that they have provided unusually deep and secluded valleys, which have acted as refugia. Species can move up and down elevational gradients to maintain thermal equilibrium during periods of rapid temperature fluctuation. The unusual climates of the river valleys have promoted the successful survival of species extirpated elsewhere. The depth of the valleys effectively limits biotic productivity through reduced insolation relative to latitude and high humidity reduces light levels further. The rivers buffer extremes of temperature due to cloud and fog formation from high humidity. The river valleys allow warmer wind from the south to penetrate far to the north during the winter monsoon.

Definition of Gaoligong Shan

Previous Definitions and Biogeography

The GLGS have been previously defined by several workers and environmental organization. Some definitions use the physical features to define the area. The best previous definition of the GLGS is that of Li: "The Gaoligong Shan is: the mountain range between Nujiang River and Irrawadi River, it is located in N 24°40′–28°30′, covering totally 111,000 square kilometers, which includes the whole territory of Tengchong County, part but most of Longling, Baoshan, Lushui, Gongshan County area, besides N Burma area (Kachin State)" (Li 2000:vii). Although, this definition has a straight-line, latitudinal cutoff in the north and omits the SW ridge in Yingjiang County it covers most of the GLGS as it is defined in this paper. Lan and Dunbar define the Gaoligong Shan Region differently: "The region referred to as Gaoligong Shan here includes all lands west of the Salween (Nujiang) River in Yunnan. The entire region is situated at the southern edge of the eastern Himalayas, the westernmost region of Yunnan Province, and in the western part of the Trans-Himalayan Mountains" (Lan and Dunbar 2000:275–276). In practice, however, they used an essentially political definition; therefore, all of the land in Myanmar including the interconnected "NE-SW Trending Ridges" and the territory on the western side of the main GLGS main ridgeline in Lushui and Fugong Counties were excluded. Although politically this was not unreasonable, natural phenomena do not follow political constructions. The World Heritage listing definition of the Three Parallel River Region of Yunnan includes only the northern part of the GLGS ending at Lushui County at the end of the very highest ridgeline. It emphasizes the role of the gorges more than that of the mountains (UNESCO 2003). The GLGS are included in the recently revised and corrected definition of "Mountains of Southwest China, Biodiversity Hotspot" used by Conservation International (Conservation International 2005). However, it includes the whole Hengduan Mountains and Longmen Mountains and so is of little use in discussing just the GLGS.

Other workers defined the area according to biogeographical or ecological considerations. The Hengduan Mountains subalpine conifer forests zone (PA0509) used by the World Wide Fund for Nature (WWF) does not extend so far south or west as does the GLGS (Carpenter 2001a). The part of the GLGS region is included in Nujiang River Lancang Gorge Alpine Conifer and Mixed Forests (PA0516). "The Nujiang River Lancang Gorge ecoregion includes the valley system through which rivers flow down from the Tibetan Plateau into the tropical hills of northern Indochina" (Carpenter 2001b). This definition missed the western slopes of Myanmar that are in Northern Triangle subtropical forests (IM0140) (Than et al. 2001). The GLGS are spread between three different ecozones according to the WWF. Similarly, the GLGS are split by many other biogeographers and ecologists. Because of its elevation and latitude, the northern part of the GLGS is often classed as part of the Tibetan Plateau; the middle reaches with Yunnan Plateau; and the southern parts as subtropical forest continuous with that of Myanmar or Thailand (Mackinnon et al. 1996; Zhao 1986). The area of western Gongshan County and Fugong County is included in the Himalayan Southern Slope Region by Zhao (1986). Mackinnon (1996) includes most of the GLGS in the Paleartic Realm, Southwest China Province but makes a new subunit for the Nujiang River Lancang Gorges Area 39f, the middle of the GLGS is within sub-unit Yunnan Plateau 39a, whereas, the south is in the Indo-Malayan Realm, Tropical South China Province, sub-unit 10 the Thailand Subtropical Monsoon Forest (Mackinnon et al. 1996).

The Definition of the GLGS as Used in this Paper

The name GLGS refers to mountain features, so it is best that it is defined by its physical geography. Therefore, the GLGS comprise the contiguous mountain ridges between the drainages of the Nujiang River (Salween River) and the Irrawadi River systems. In the north beyond the Irrawadi River headwaters the GLGS are between the Sang Qu River (Luhit), a tributary of the Yarlung Zangbo River (Brahmaputra) and the Nujiang River (Figs. 12–14).

The contiguous ridges were defined as land over 1800 m. The areas above 1800 m form interconnected ridges that join the Hengduan Mountains. This elevation was chosen as it is the cutoff of the "Monsoon Evergreen Broad-Leaves Forest" belonging to the *Castanopsis hystrix* and *Castanopsis echidoncarpa* forest type. This forest is distributed in moist ravines, on the east-facing slope in the southern part of the region, at elevations rising to but not above 1800 m (Li 2000). Using "Monsoon Evergreen Broad-Leaves Forest" for choosing the elevation for the ridges was helpful for two reasons. First, there are no barriers between "Monsoon Evergreen Broad-Leaves Forest" within the Gaoligong Shan and the same zone that spreads throughout a large area to the south and east covering broadly most of Myanmar and much of Southeast Asia. Second, above 1800 m the ridges are complete and continuous within the GLGS (Fig. 29).

In areas where there is neither a river barrier nor an extending ridge, the study area was curtailed at the 1000 m mark. This was necessary for only two small areas to the southwest of the "NE-SW Trending Ridges." Here the essentially flat area north of the Dayang River and south of the next tributary of the Irrawadi extend far into Myanmar before joining the Irrawadi. This area is also extensively farmed.

The Dayang River was followed as the boundary in the south until it turned to the north near Nansong Town. Then the boundary was cut across the top of Lianghe County from Nansong to Pingshan and the Longchuan River. The Longchuan River provides the boundary of the GLGS until it reaches the western slope of the GLGS ridge. Here the Longchuan River turns north along the border of Tengchong and Longling Counties. The final section of the GLGS southern border is encompassed by a line following the lowest contours round the end of the Mangshi River until it

reaches the first tributary of the Nujiang River the Supa River. The Supa River rises north of Zhen'an Village and runs from the northwest slope of Daxue Mountain on the GLGS ridge to travel west, before traveling south, southeast, and then eventually east to encircle the southern point of the GLGS main ridge. This definition provides the shortest route between the Nujiang River and Irrawadi drainages that encompasses the entire ridge complex.

As per the discussion of the GLGS above, the low ridges to the southwest of the GLGS, low ridges in Yingjiang Lianghe Counties and those in western Longling that extend into Luxi County could be argued to be also a part of the Gaoligong Shan. However, the decision not to include them was based on hypsographic arguments alone. The ridges are not contiguous but are separated by low points or watershed boundaries. These lower ridges all belong to the Irrawadi system not the Nujiang River drainage system. Therefore, they lie outside of the watershed between the Nujiang River and Irrawadi. The Nujaing-Irrawadi drainage boundary is at the Longchuan River, which forms the border between Longchuan, Lianghe, and Luxi Counties and this boundary is north of those County's southernmost ranges.

The Nujiang River and Irrawadi River Valleys provide the cutoff points to the Gaoligong Shan as these are the lowest points. The GLGS are defined as a hypsographic feature. On the opposite bank of these river drainages the slope must, by definition, rise again. Therefore, the contiguous slope runs only between the rivers.

FIGURE 29. Map indicating all contiguous land over 1800 m in brown.

The main observations about the physical features of the GLGS are presented in Table 2.

Conclusions and Implications for Biodiversity

The Hengduan Mountains are a haven of biodiversity. The GLGS are the most isolated of the ranges of the Hengduan Mountains, due in large part to the drainage pattern. The potential of the GLGS for preserving biodiversity, as well as causing it, may be unique in Eurasia. The position of the GLGS in Eurasia enables them to be a reservoir of biodiversity for all of East Asia.

The GLGS straddle the Indo-Malayan and the Paleartic biogeographic realms and have been split into different biogeographic provinces by different workers. The descriptions of these provinces have not caught up with modern understanding of tectonics, leading to considerable confusion. The physical geography of the GLGS is the result of tectonic activity. All of the plates form-

TABLE 2. General Facts about the Gaoligong Shan

1. Maximum Linear Length along Main Ridge 585 km.
2. Minimum Linear Length along NE-SW Ridge 565 km.
3. Maximum Width 150 km in the south near Tengchong.
4. Maximum Width 100 km in the north near Gongshan Town.
5. Minimum Width 48 km near Fugong Town.
6. Bounding Box 97.47°E, 29.51°N and 99.03°E, 24.37°N decimal degrees.
7. Maximum Elevation 6318 m southeast of Zayü County.
8. Minimum Elevation 183 m Drainage of the Nmai River in Myanmar.
9. Minimum Elevation 620 m Drainage of the Nujiang River.
10. Mean Elevation 2638 m.
11. 62% of the land lies between 1500–3500 m.
12. 11% of the land is above the approximate tree-line of 4500 m.
13. Only 7.8% of the surface area is essentially flat (slope < 3%).
14. Mean slope for the whole area including the drainages is 13.4%.

Elevation Band	*Surface Area In Plan View km^{-2}*	*3d Surface Area Along Slope km^{-2}*	*Area in Band 3d Surface km^{-2}*	*% of Total 3d Area in Band*
0–499	41937	44147	279	0.63
500–999	41661	43867	1642	3.72
1000–1499	40056	42226	4078	9.24
1500–1999	36114	38147	8395	19.02
2000–2499	28007	29753	8453	19.15
2500–2999	19951	21300	6040	13.68
3000–3499	14309	15260	4520	10.24
3500–3999	10133	10740	3491	7.91
4000–4499	6891	7249	3334	7.55
4500–4999	3763	3915	3112	7.05
5000–5499	778	803	798	1.81
5500–5999	4	5	5	0.01
Total Area	41937 km^{-2}	44147 km^{-2}		

ing the GLGS are from Gondwanaland, but some of them have been in contact with the Eurasian Plate (Paleartic Biogeographic Realm) for upwards of 200 million years. The Indo-Malayan region is physically an assembled unit composed of units of vastly different ages. For a review of current usage of China's zoogeographical zonation refer to Mackinnon et al. (1996).

Tectonic forces themselves create a genetic "melting pot" for biodiversity. The paleo-separation and subsequent re-aggregation of plates from Gondwana and the collision of plates from different paleo-continents laid a foundation of high genetic diversity. This was accentuated by the region's long and complex uplift history. Slowly rising landmasses provided opportunities for adaptive changes in resident organisms. Geographic isolation due to the tectonically driven incision of the landmass by massive rivers has further enhanced biodiversity through vicariance.

Tectonic forces give rise to a diversity of host rock and soil types. This diversity has further enhanced the potential for increased biodiversity. The great range of host rocks, elevations lati-

tudes, and monsoon conditions within the GLGS has given rise to considerable soil diversity. This, in turn, gives rise to floristic diversity and heightened biodiversity at all higher trophic levels. Adaptive forces related to tectonics operate at both the macro as well as the micro landscape scale. The many preserved volcanic cones in the area of Tengchong resulting from tectonic melting, could be a source of local adaptation and vicariant speciation of smaller organisms as is known from other volcanic fields, e.g., *Drosophila* on Hawaii.

Summary

摘要

高黎贡山是由不寻常的地质连锁成形运动构成的一个独特地区。同其它相近纬度的地区比较，由于缺少南向坡面和具有较深的山谷，它的气候更为温和。冷空气从周围的高地注入，导致了多雾和气温倒位现象。从西面来的潮湿空气，在高海拨山体的西面形成大量降雨。季风气候的形成改变了降雨模式，以致大量降雨在短期之内于该地区倾降下来。沿山脊被挤压的樊风进一步改变了气候。透过减少和纬度相关的隔离，山谷的深度限制了生物的生产能力。这一地区的河流的存在，缓冲了由于潮湿而成的多云多雾导致的极端气温。上述所有不寻常的物理现象，它们共同作用的结果增加了小气候形成的机会。

怒江和伊洛瓦底江的古老性，河流规模和长度是形成淡水生生物多样性进化的可观因素。河流自身同时也是有机体不可逾越的迁移和散布屏障，它将高黎贡山内部与周边区域隔离开来。河流从生物地理上分割了这个区域（Jablonski and Pan 1988）。从而导致了高水平的特有性（Mackinnon et al. 1996）。河流的屏障作用在于阻止散布，并保护该地区不受外来物种的侵入而失去完整的特有性。高深河谷的另一作用是提供难得的深而隐蔽的气候避难所。物种能沿海拔高度倾斜而维持气温急剧波动期间的热量平衡。不寻常的河谷气候促成了那些在其它地区灭绝的物种能在该地成功存活。用当地居民的话来说就是：“这里一天之内四季分明”。

结论

高黎贡山的地貌来源于地球物理运动，是多次发生于该地的气候变化结果。古地中海时代，该地的气候既炎热又潮湿。季风形成后，变为较为干躁和凉爽。自季风气候在早于七百万年前形成后，许多发生于该地区的物种已经跨越了这个间隔，适应了季节性的季风气候。孤立的高黎贡山自然坏境可能提供了相对较低的捕食动物负荷。自然动力和地球物理作用本身为形成生物多样性替代物种的适应提供了广阔的空间。加深了诸如古气候变化、季风和冰区避难所形成，而导致全球性的影响。这类全球性影响的方式已在横断山得到表达，而在高黎贡山所不同的是，它对低地与周围东西走向山地的影响。这个对地球作用的独特性增加了该地的生物多样性。高黎贡山以其数量繁多的孓遗、特有和替代种闻名。高黎贡山的独特性保证了其生物多样性的繁盛，艰险的地形制约了当地的农业发展并进一步限制了高度的人类活动，从而对其生物多样性具有保护作用。

Acknowledgements

Thanks for support to Environmental Systems Research Institute (ESRI) for supplying data and software to the California Academy of Sciences. Thanks also to Dr. Nina G. Jablonski for advice and help with editing and to Dr. Peter Fritsch and Dr. Bruce Bartholemew for comments on an earlier draft and to several anonymous reviewers whose comments led to a greatly improved presentation. Thanks also to Dr. Nina G. Jablonski for the invitation to visit the GLGS. Dr. Lihua Zhao, Department of Botany, California Academy of Sciences, prepared the Chinese versions of the conclusions and summary statements that accompany this paper. This publication represents Contribution No. 39 of the Center for Biodiversity Research and Information (CBRI) and Contribution No. 27 of the China Natural History Project, both at the California Academy of Sciences.

Cartography and data.— Care was taken to ensure that political borders were depicted representatively; however, they are provided only for indicative purposes and do not represent any territorial claim or agreements. Representation of borders will depend on the dataset used and differs slightly between maps. The reader should note that the borders are disputed in a number of areas within the Hengduan Mountains region. No opinion is expressed or implied in the cartography or text. Place names are given to be as informative as possible to the general reader; they do not mean to imply any special meaning to the names used in this paper. Place names are taken from the Map of the People's Republic of China (Carto. Pub. Hse., 1984) and from common usage.

The data used in this paper came from a variety of sources. The following datasets were used either alone or in combination to produce the maps (ESRI 1996; F.A.O. 2005; Steinshouer et al. 1997; USGS 1993, 2000, 2004; Wandrey and Law 1997). All maps are original maps produced from the data using ArcGIS© and ArcView© (ESRI 1999, 2004).

References

Anonymous. 1984. *Map of the People's Republic of China.* Beijing, Cartographic Publishing House Esselte Map Service AB Sweden.

Bi, S. 2004. Study on Dynamic Numerical Simulation of Mountain System in Tibet Plateau. *Journal of Mountain Science* 1(3):211-222.

Carpenter, C. 2001a. Hengduan Mountains subalpine conifer forests (PA0509). *<http://www.worldwildlife.org/wildworld/profiles/terrestrial/pa/pa0509_full.html>*

Carpenter, C. 2001b. Nujiang River Langcang Gorge alpine conifer and mixed forests (PA0516). *<http://www.worldwildlife.org/wildworld/profiles/terrestrial/pa/pa0516_full.html>* 2005, 4 Feb.

Conservation International. 2005. Mountains of Southwest China. Biodiversty Hotspots. <http://www.biodiversityhotspots.org/xp/Hotspots/china/> 2005, 27th Feb 2005.

Dutch, S. 1998. History of Global Plate Motions. Wisconsin. *<http://www.uwgb.edu/dutchs/platetec/plhist94.htm>* 2005, Feb 07.

ESRI. 1996. *ArcAtlas: Our Earth.* Environmental Systems Research Institute, Data CD ROM

ESRI. 1999. *ArcView.* Computer Program by Environmental Systems Research Institute, Redlands, California, USA.

ESRI. 2004. *ArcGIS.* ArcInfo. Computer Program by Environmental Systems Research Institute, Redlands, California, USA.

F.A.O. 2005. The State of the world land, water and plant nutrient resources: People's Republic of China. Food & Agriculture Organization: United Nations. *<http://www.fao.org/ag/agl/swlwpnr/reports/y_ea/z_cn/en/e_soils.htm>* 2005, 2 Feb 2005.

Guo, S.-M., H.-F. Xiang, R.-Q. Zhou, X.-W. Xu, X.-Q. Dong, and W.-X. Zhang. 2000. Longling-Lancang

fault zone in southwest Yunnan, China A newly-generated rupture zone in continental crust. *Chinese Science Bulletin* 45(4):369–372.

HALL, R. 1997. Cenozoic plate tectonic reconstruction of SE Asia. Pages 11–23 *in* A. Fraser, S. Matthews, and R. Murphy, eds., *Petroleum Geology of SE Asia*, vol. 126. Geological Society of London, London, UK.

JABLONSKI, N.G. 1998. The response of catarrhine primates to Pleistocene environmental fluctuations in East Asia. *Primates* 39:29–37.

JABLONSKI, N.G., AND Y.R. PAN. 1988. The evolution and palaeobiogeography of monkeys in China. Pages 849–867 *in* P. Whyte, ed., *The Palaeoenvironmenta of East Asia from the Mid-Tertiary*, vol. II. Centre of Asian Studies, Hong Kong, China.

LAN, D.-Y., AND R. DUNBAR. 2000. Bird and mammal conservation in Gaoligong Shan Region and Jingdong County, Yunnan, China: Patterns of species richness and nature reserves. *Oryx* 34(4):275–286.

LI, H. 2000. *Flora of Gaoligong Mountains*. Science Press, Beijing, China. 1344 pages.

LIN, T., C. LO, H. LEE, T. LEE, AND M. YEH. 2004. New geochronological data on the Jiali fault zone, Southeastern Tibet, and its tectonic implication. *Eos. Transactions of the American Geophysical Union, Western Pacific Geophysical Meeting, Supplement, Abstracts* 85 (28) T13 B 50.

MACKINNON, J., M. SHA, C. CHEUNG, G. CAREY, Z. XIANG, AND D. MELVILLE. 1996. *A Biodiversity Review of China*. World Wide Fund for Nature International, Hong Kong, China. 529 pages.

MEYERHOFF, A., M. KAMEN-KAYE, C. CHEN, AND I. TANNER. 1991. *China: Stratigraphy Paleogeography and Tectonics*. Kluwer, Dordrecht, Netherlands. 188 pp.

NASA. 2004a. *Visible Earth Modis Cloud Free Data.* Goddard Space Flight Center.

NASA. 2004b. *Pan-folded Ranges, Image No. STS102-711-9_3.JPG.* International Space Station, Image Analysis Laboratory, NASA Johnson Space Center.

NASA. 2004c. *Zayü R. V., Hengduan Mts., Snow Image No. ISS010-E-7344.JPG 28.5N 98.0E.* International Space Station, Image Analysis Laboratory, NASA Johnson Space Center.

REPLUMAZ, A., H. KARASON, R. VAN DER HILST, J. BESSE, AND P. TAPPONNIER. 2004. 4-D evolution of SE Asia's mantle from geological reconstructions and seismic tomography. *Earth and Planetary Science Letters* 221:103–115.

SCOTESE, C. 1994. *Continental Drift*, Edition 6. University of Texas at Arlington., Arlington, Texas, USA. Part of the Paleomap Project. <*http://www.scotese.com/earth.htm*>

SMITHSONIAN. 2005. *Global Vocanism Program, Tengchong Summary*. Global Volcanism Program, Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington DC. <*http://www.volcano.si.edu/world/volcano.cfm?vnum=0705-11-*> 2005, Febuary 1st.

SOCQUET, A., AND M. PUBELLIER. 2003. Cenozoic to Active Deformation North Western Yunnan (Myanmar China Border). *Geophysical Research Abstracts* 5, 10157.

SOEDING, E. 2004. *Ocean Drilling Stratigraphic Network Plate Tectonic Reconstruction Service*. Ocean Drilling Stratigraphic Network, Bremen & Kiel. <*http://www.odsn.de/odsn/services/paleomap/paleomap.html*> 2005, January.

STEINSHOUER, D., J. QIANG, P. MCCABE, AND R. RYDER. 1997. Maps showing geology, oil and gas fields, and geologic provinces of the Asia Pacific Region. Page 16 in *World Energy Project of the U.S. Geological Survey*, Menlo Park, California. U.S. Geological Survey Open-File Report 97-470F.

THAN, U.-T., T.-A. MOE, AND E. WIKRAMANAYAKE. 2001. Northern Triangle subtropical forests (IM0140). <*http://www.worldwildlife.org/wildworld/profiles/terrestrial_im.html*>

UNESCO. 2003. *Three Parallel Rivers of Yunnan Protected Areas*, (Paragraph 27, Communique 8C.4). World Heritage. United Nations Educational, Scientific and Cultural Organization, Paris.

USGS. 1993. *Global Topographic 30 Arcsecond Data Set* (*GTopo30*). U.S. Geological Survey's EROS Data Center, Sioux Falls. Digital Data <*http://edcdaac.usgs.gov/gtopo30/gtopo30.asp*> Acessed 2003.

USGS. 2000. *HYDRO1k Elevation Derivative Database*. U.S. Geological Survey in cooperation with UNEP/GRID, Sioux Falls. <*http://lpdaac.usgs.gov/gtopo30/hydro/*> Accessed 2003.

USGS. 2004. *Shuttle Radar Topography Mission 3 Arcsecond Data Set Series 1*. U.S. Geological Survey's EROS Data Center, Sioux Falls. Digital Data <*http://edcsns17.cr.usgs.gov/srtmdted2/*> Accessed 2004.

WANDREY, C., AND B. LAW. 1997. *Maps Showing Geology, Oil and Gas Fields and Geologic Provinces of South Asia.* Page 12 *in* World Energy Project of the U.S. Geological Survey, Menlo Park, California. U.S.

Geological Survey Open-File Report 97-470C.

Wang, J.-H., A. Yin, T. Harrison, M. Grove, Y.-Q. Zhang, and G.-H. Xie. 2001. A tectonic model for Cenozoic igneous activities in the eastern Indo Asian collision zone. *Earth and Planetary Science Letters* 188:123–133.

Zhang, Y.-Z., and Y.-L. Lin 1985. The distribution tendency of land mammals in China and adjacent areas. *Acta Zoologica Sinica* 31:187–197.

Zhao, S.-Q. 1986. *Physical Geography of China*, C. Salter, ed. Science Press and John Wiley, Beijing and New York. 221 pp.

PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 29, pp. 557–599, 65 figs., 3 tables December 30, 2005

The Giant Pill-Millipedes of Madagascar

Revision of the Genus *Sphaeromimus*, with a Review of the Morphological Terminology (Diplopoda, Sphaerotheriida, Sphaerotheriidae)

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The Malagasy sphaerotheriid genus *Sphaeromimus* DeSaussure and Zehntner, 1902 is revised. Known heretofore from a single male specimen, the genus now contains three species, *Sphaeromimus musicus* (DeSaussure and Zehntner, 1897), *Sphaeromimus splendidus* sp. nov. and *Sphaeromimus inexpectatus* sp. nov. The female of *S. musicus* is described here for the first time. The mouthparts of giant pill millipedes were observed for the first time using scanning electron microscopy and species- and genus-level characters are illustrated. Intraspecific variation of the female stridulatory organ, the 'washboard' is described. For the first time in Malagasy Sphaerotheriida, some ecological comments are given. Characters found in the male telopods and the female stridulatory organ (the washboard) indicate that characters employed previously for the definition of subfamilies and tribes cannot be maintained and the monophyly of such groups remains questionable.

KEYWORDS: *Sphaeromimus*, Sphaerotheriida, giant pill-millipedes, Madagascar, Diplopoda.

Based on its species-richness and high level of endemism (Myers et al. 2000), Madagascar was recently listed among the eight eminent biodiversity hotspots of the world. Madagascar, as the fourth largest island of the world, harbors a diversity of different ecosystems, resembling in this regard a small continent. Due to its over 150 million years of isolation from the closest continental landmass Africa (Rabinowitz et al. 1983; Wells 2003), its flora and fauna are unique and very distinct from that of other regions of the world. Furthermore, the fauna and flora of Madagascar are extremely poorly known, as is the case for many species-rich regions outside northwestern Europe and North America. Ongoing faunistic research on the island of Madagascar continues to discover numerous new species, even among vertebrates (Jenkins 1993; Glaw and Vences 1994; Sparks and Stiassny 2003). Since the destruction of natural habitats is advancing on the island at an alarming rate, alpha-taxonomic research with regards to invertebrates is extremely urgent, as many species may vanish before ever being described. Three Malagasy ecosystems, the east coast littoral forest, highland vegetation and the western dry deciduous forests have shrunk by over 90% of their former distributions and belong now to the most threatened ecosystems of the world (Ganzhorn et al. 2001; de Gouvenain and Silander 2003; Vincelette et al. 2003).

The millipede genus *Sphaeromimus* revised below illustrates the understudied invertebrate diversity as well as the threatened status of its species. The diverse arthropod class Diplopoda is

one of the severely understudied animal groups. Over 9,000 species have been described so far (an exact species catalog does not yet exist) and estimates of millipede species richness are given as approximately 80,000 species worldwide (Hoffman 1980). As far as it is known, millipede species are often microendemic with very small distribution ranges; in some cases related species may occur just 20 km apart (Enghoff 1983; Hamer and Slotow 2002; Mesibov 1998) Despite the fact that most millipedes are macroinvertebrates (adult size from a few millimeters to 28 cm body length in *Archispirostreptus gigas* (Peters 1855)) and are of considerable ecological importance for litter breakdown within the decomposition cycle (Wolters and Ekschmitt 1997; Curry 1994; Crawford 1992; Schaefer 1990), biological research on the class suffers from lack of alpha-taxonomic attention, mainly due to the paucity of taxonomic experts for the group.

The Malagasy giant pill-millipede genus *Sphaeromimus* was heretofore known from a single male specimen of *Sphaeromimus musicus*. Among recently collected material by the senior author and from survey work by Goodman (Field Museum) and Griswold (California Academy of Sciences), female specimens of *S. musicus* and material of two new species of the genus were discovered. The four-jointed anterior telopods are the distinguishing feature of the genus. In *Zoosphaerium* Pocock, 1895, the other genus of giant pill-millipedes occurring in Madagascar, the anterior telopods have only three joints. Furthermore, features of the female vulva in *Sphaeromimus* do not agree with characters used by Jeekel (1974) in the most recent classification of the millipede order Sphaerotheriida and further phylogenetic analyses of the order will be required to clarify its internal classification.

The two newly discovered species of *Sphaeromimus* described below are each known only from small, isolated remnants of the southern littoral forest on Madagascar. This very limited distribution, the still ongoing anthropogenic influence in these remaining littoral forest patches and further possible disturbance of the habitat by mining projects may make these two new species likely to be among the most endangered millipede species of the world.

Material and methods

The senior author (T.W.) collected specimens of the two new species described here during fieldwork in Madagascar in March and April 2003. Specimens of *S. musicus* were borrowed from the California Academy of Sciences (CAS) and the Field Museum (FMNH).

Specimens were euthanized using ethyl acetate, straightened and preserved in 70% ethanol. All measurements are in mm.

Dissections, illustrations.— Dissections were made with a scalpel, in very small specimens with a dissecting pin. The following structures were dissected (a) the anterior and posterior pair of telopods, which were separated from each other using a needle; (b) the left leg of the 9th pair in males and females; (c) the 2nd leg pair in females; (d) the 1st leg pair with 1st sternite in females and males, (e) the subanal plate with 'washboard' in females; and (f) a section of the endotergum from a tergite in the center of the body, removed using scissors. Dissected specimen parts were cleared in clove oil. Drawings were done using a camera lucida mounted on a dissecting or compound microscope depending on size of specimen. Small specimens were held in position using clean sand at the bottom of dissecting dishes.

For scanning electron microscope examinations the following parts were dissected: (a) The right/left antennae were cut off with a scalpel near the insertion in the head. (b) The gnathochilarium was removed by cutting along its base with a scalpel and separating the tentorium with scissors. After removal of the gnathochilarium, (c) the mandibles were cut easily at the first joint with scissors and scalpel. (d) The epipharynx was separated from the head with a needle and then pulled

out with forceps. (e) The remaining head capsule was separated from the body using forceps. (f) The 2nd leg coxa of males was removed from the body.

SEM preparations.— Specimens were dehydrated through a series of alcohol to 100% ethanol, mounted on stubs using sticky tabs and air-dried overnight. The 2nd leg coxa of the male with the gonopore was critical point-dried. Stubs were sputter-coated with gold and observed with an AMRAY 1810 SEM (Field Museum).

Terms

As is true for many millipede groups, systematic treatments of the order Sphaerotheriida are scant and were done by a few authors, e.g., Verhoeff (1927, 1928, German) and Attems (1897, German), Silvestri (1917, Latin), Jeekel (1974, English) and recently by VandenSpiegel et al. (2003, English). Authors used terms in the various languages and the equivalency of such terms in the different treatments is sometimes difficult to determine. Since millipede morphology is less well known than that of other arthropod groups, which in the past have been explored more extensively with high quality light microscopy and scanning electron microscopy, the nomenclature of several morphological terms is currently neither standardized nor stabilized in the Diplopoda. For that reason we list terms used in this paper, along with terms used by other authors for apparently the same structure. Our use of such terms does not necessarily imply homology.

Anal shield.— Formed by the fused tergites of the last 3(?) diplosegments (= pygidium of authors, e.g., VandenSpiegel et al. 2003). In males of some sphaerotheriid species the anal shield is invaginated in the middle (Fig. 1IH). Such invagintion may play a role in mating behavior.

Antennae.— The first visible joint of the antennae, inserting in the antenna socket, is termed 1st antennomere.

Anterior paratergite depressions.— Denotes the anterior rim of the lateral extensions of the tergites (Paratergite, see below), a well circumscribed slightly concave area which glides under the posterior margin of the proximal tergite during volvation (Figs 1, 28–29, 50). Recent treatments on Sphaerotheriida did not explicitly discuss this morphologically distinct area.

Bursa.— Jeekel (1974) applied this term for the structures of the female vulva below the operculum. The 'bursa' consists of two sclerites, the exterior and inner plate (EP and IP) (Figs 5, 33, 55).

Endotergum.— The underside of the posterior margin of the tergites carries crenulations, spines and bristles, often in a species-specific arrangement (see VandenSpiegel et al. 2003; 'Unterblatt' *sensu* Verhoeff 1928: plate 10, fig. 123).

Gnathochilarium.— Since homologies with sclerites of helminthomorph gnathochilaria are unresolved (see Hoffman 1976:125), the sclerite terminology used here for sphaerotheriid gnathochilaria is descriptive. Usage of the term lamellae linguales below does not constitute a statement of homology.

Harp.— A set of ridges located on a discrete plate on the first joint of the anterior telopods of males (Figs 8, 37, 58).

Inner horns of posterior telopods.— Lobe-like projections attached mesally to the syncoxite, termed coxal horn by VandenSpiegel (2002), and 'Hörner des Syncoxit' by Verhoeff (1928:676). Indicated here by IH = inner horn. Also, see below under 'Telopods' (Figs 11, 35, 57).

Lamellae linguales.— Two longitudinal sclerites between the left and right paramentum of the gnathochilarium. In *Sphaeromimus*, the two sclerites are partly fused. At the distal tip of the lamellae linguales are pads carrying sensorial cones (Fig. 48). These pads were termed 'Zäpfchenkappen' by Verhoeff (1928:872). The homology of these two sclerites with the lamellae

linguales of the Helminthomorpha is questionable (see Hoffman 1976).

Male gonopore.— Opening of the vas deferentia on the posterior wall and the inside margin of the coxa of the 2nd leg pair (Fig. 27). Verhoeff (1928:695) stated that in Sphaerotheriida the male genital opening consists of a small, inconspicuous pore; other authors (e.g., VandenSpiegel et al. 2003) described somewhat more complex structures and denoted them with the terms penes and pseudopenes. DeSaussure and Zehntner (1897/1902) illustrated the male gonopore in several species and genera of the Sphaerotheriida showing different structural elements.

Molar plate process.— Elongated process attached to the upper side of the molar plate towards the roof of the head (Figs 18, 40), as it occurs in the millipede clade Pentazoniida (comprising the orders Glomerida, Glomeridesmida and Sphaerotheriida). This structure is very prominent in sphaerotheriids and can be found on illustrations of other pentazonid mandibles (e.g., in glomerids by Köhler and Alberti 1990, fig. 2-3; in sphaerotheriids by Silvestri 1917, fig. 2). No term has been coined for this structure.

Paratergite (Verhoeff 1928:385, German).— Lateral extensions of the tergites. The anterior paratergite depressions (see above) are located on the dorsal side of the anterior margin of the lateral extensions of the tergites (Figs 1, 28–29, 50). Verhoeff (1928:385) also used the term 'Seitenlappen.' These lateral tergite extensions were sometimes called paranota. Paranota is commonly used for the metazonite extensions in Polydesmida. Since the latter denotes a different anatomical part than the 'Paratergite' *sensu* Verhoeff in the Pentazonia, we prefer to call the structure lateral tergite extensions or paratergite.

Sensorial cones.— Myriapods feature a variety of sensorial structures, one of which are cones with a small pore on their tip. All such structures called sensorial cones in this paper have this particular anatomy. The distribution of such cones may reveal species- or genus-specific characters.

Subanal plate.— Hypoproct or ventral scale of authors, equipped with a stridulatory organ (washboard) in females of *Sphaeromimus*.

Telopods.— In the Pentazonia, males have two pairs of modified legs, the anterior and posterior telopods, at the end of their bodies. These telopods are involved in mating behavior and sperm transfer. It is commonly assumed that these are homologous to walking legs and thus the most proximal joint is called the coxite. In Sphaerotheriida, the coxites of each telopod pair are fused, forming a 'syncoxite.' The homology of the more distal joints with podomeres is uncertain. Here, the joints distal to the syncoxite are indicated by numbers 1–3 (posterior telopods) or 1–4 (anterior telopods) respectively. Some authors (Mauriès 2001) distinguish between the anterior and posterior telopod by using the terms 'paratelopod' (anterior telopod) and telopod (posterior telopod).

Thoracic shield ('Brustschild' *sensu* Verhoeff 1928:473).— Formed by the enlarged tergite of the 2nd body segment, the one following the collum. It features wide lateral lobes with a distal concave groove ('Gruben des Brustschildes' *sensu* Verhoeff 1928:473) and a conspicuously raised brim, involved in volvation (Verhoeff 1928:473).

Vulva.— The vulva consists of the bursa and the operculum. Many authors used the term 'cyphopods' for the female organs in millipedes.

Washboard.— A stridulatory apparatus termed washboard by Jeekel (1999) is located on the subanal plate (=Hypoproct or ventral scale) at the caudal end of the body of females (Figs 7, 34, 55).

Abbreviations

CAS	California Academy of Sciences, San Francisco, USA
FMNH	Field Museum of Natural History, Chicago, USA
MNHN	Muséum National d'Histoire Naturelle, Paris, France

12T	12th tergite
AI	Anal shield invagination
AS	Anal shield
EP	Exterior plate of vulva
IH	Inner horns on syncoxite of posterior telopods.
IP	Inner plate of vulva
O	Operculum of vulva
PL	Pleurite
S	Sternite
TO	Tömösváry organ

Results

Genus *Sphaeromimus* DeSaussure and Zehntner, 1902

Sphaeromimus DeSaussure and Zehntner, 1902.
Sphaeromimus, Attems 1942.— Jeekel 1971, 1974, 1999 — Enghoff 2003.

Type species.— *Sphaeropoeus musicus* DeSaussure and Zehntner, 1897. Other species included: *Sphaeromimus splendidus* sp. nov., *Sphaeromimus inexpectatus* sp. nov.

The Malagasy sphaerotheriid genus *Sphaeromimus* was first described by DeSaussure and Zehntner (1902) in their important work on the Diplopoda of Madagascar. Originally, the genus contained a single species, *Sphaeromimus musicus* (DeSaussure and Zehntner, 1897, sub *Sphaeropoeus*), known only from a single male. Consequently, only male sexual characters were given with descriptive details focusing on the telopods. The unusual features of the species prompted Jeekel (1999) to suggest that the then known *Sphaeromimus* specimen may have been "mislabelled or [represents] an introduced Indian sphaerotheriid". With the collection of male and female specimens of *S. musicus* at three different localities and the discovery of two new *Sphaeromimus* species, described below, it is now demonstrated that *Sphaeromimus* forms an established part of the endemic Malagasy fauna. Since the genus is no longer monotypic, genus-specific characters can be given.

The genus *Sphaeromimus* can be distinguished from the only other Malagasy sphaerotheriid genus *Zoosphaerium* Pocock, 1895, on the basis of numerous characters. The genus description given below includes the characters DeSaussure and Zehntner (1902) mentioned in the original description of the genus.

Diagnosis.— Members of the genus *Sphaeromimus* can be distinguished from *Zoosphaerium* by the following combination of characters: antennae short, with six joints, antennomeres without small spines and first antennomere without indentation. Apical antennomere rounded with numerous (up to 77) sensorial cones (apical antennomere cylindrical with four or more sensorial cones in *Zoosphaerium*), number of cones species-specific. Tarsi in *Sphaeromimus* broad (2.5–3 times longer than broad, *Zoosphaerium* up to 4.5 times longer than broad), tarsal tip densely covered with ventral spines. Anterior telopods with four joints (*Zoosphaerium* with three joints). Males with numerous strong stridulatory ridges on a plate termed 'harp' located on the first joint of the anterior telopods. Females with prominent, long stridulatory ridges on the subanal plate called 'washboard.' Washboard divided into two parts by a suture of variable length depending on species. Cyphopod sclerites in the bursa of *Sphaeromimus* of unique shape. In *Sphaeromimus,* operculum of vulvae much longer than the 2nd leg coxa, without a central depression (operculum subreniform in *Zoosphaerium*). This high number of characters allows easy differentiation between the two Malagasy sphaerotheriid genera.

Description.— Known members of the genus range from 15 to 35 in body length, thoracic shield width ranges from 6.8 to 17.6.

Head: only antennae with genus-specific characters, remaining features of head agree well with those found in most other sphaerotheriids. Eyes with numerous greenish ocelli, two of which are larger and one ocellus laterally displaced and separated (Figs. 24–25). Clypeus with single tooth (called labrum tooth by other authors), surrounded by hairs set in small pits. Tömösváry organ developed as a small round pit as in all known members of the order (Fig. 25). Center of posterior edge of head with or without patch of very small bristles (Figs 14, 39).

Antennae: antennae short, six visible antennomeres more or less short and rounded. First antennomere without spines, 6th antennomere prominent, big, flat and longer than the others, carrying many (40–77) sensorial cones (Figs 20, 43, 61).

Mouth parts: external tooth of mandible with a distinct 'step' (Figs 18, 40), with 6 or 7 pectinate lamellae, apical teeth of pectinate lamellae broad and short (Figs 19, 41), number of teeth declining from apical to proximal pectinate lamellae. Gnathochilarium more or less hairy, with a few sensorial cones lateral of the palpi (Figs. 15–16, 47, 49). Centrally located pads (='Zäpfchenkappen' *sensu* Verhoeff) on the anterior edge of the lamellae linguales with sensorial cones (Fig. 48). Tip of palpi with numerous sensorial cones distributed regularly around the tip. Epipharynx very similar in shape as known from other sphaerotheriid taxa (see Verhoeff 1928:841, fig. 419) (Fig. 45).

Thoracic shield: ridges on lateral lobes of thoracic shield absent. Anterior rim of lateral lobes broad, used in volvation.

Tergites: surface varies somewhat but mostly hairless and almost polished, except for the anterior paratergite depressions (see Material and Methods) which are more or less densely covered with hairs. Tergites always without a median keel. Tergites 3–12 each with a black carina ventrally on the anterior section of the tergites. Carinae apparently function as a locking device (Verhoeff 1928:479), fitting over the rim of the lateral extension of the thoracic shield (Figs. 1, 28–29, 50). Endotergum variable, species-specific crenulations, marginal ridge and bristle patterns, marginal bristles branched (Figs. 17, 23, 44, 62).

Sternite: first sternite with a sclerotized ledge along the anterior sternite lobe (Figs 4, 31, 53). Sternite lobe long, curved towards the legs, reaching the apical edge of coxa. Coxae and sternites without spines, but sternites three and beyond with a spine-like process which reaches about to the stigma opening of the anterior sternite.

Anal shield: shape of anal shield not variable within genus. Males of *S. musicus* with a small invagination as described in other sphaerotheriids (VandenSpiegel et al. 2003; Jeekel 1986). Anal shield sometimes with a few small isolated hairs and a patch of hairs in the corners towards the 12th tergite. Ventral side of anal shield with single black locking carina (='Verschlussleiste' Verhoeff 1928:479) on each side, locking carina with a slight central constriction (Figs. 3, 30, 52).

Legs: remarkably short and broad, especially the tarsus, being only 2.5–3 times longer than broad. Tarsi of first two leg pairs with three to five ventral tarsal spines and a straight apical claw. Tarsi of leg pair 3–21 with 10–15 ventral spines on the apical part and a curved apical claw with one apical spine. Coxal lobes present, with small black triangular spines, variable in the genus. Femur with toothed ridge (Figs. 2, 26, 33, 51). Prefemur of last pair of legs basally with a small sclerotized knob on posterior side.

Female sexual characters: subanal plate with washboard, consisting of well-developed stridulation ridges. Stridulation ridges always very long, ending just in front of the anterior margin of the washboard. Washboard with distinct median longitudinal groove, posterior rim of washboard with a central invagination. Shape of vulva unique. Operculum rounded and very long, always longer

than the coxa and can reach about half of the length of the prefemur. Exterior and inner plates (EP, IP) below the operculum (termed bursa by Attems 1928; Jeekel 1974). Cyphopod sclerites consisting of two triangular apical sclerites and a much larger smoothly rounded third sclerite, all visible as dark structures near the suture of the vulva between inner and exterior plate (Figs. 5, 32).

Male sexual characters: male gonopore conspicuous, located slightly above the middle and near the inside margin of the coxa of second pair of legs. Gonopores apparently complex, partially closed by a round sclerotized plate carrying a few long hairs and featuring at least two membranous folds (Figs. 6, 27). *Anterior telopods:* with four joints in addition to the syncoxite. Harp on plate of first joint with three or more prominent stridulation ridges (Figs 8, 37, 58). Posterior side of second joint always with a large immovable lobe-like flat projection. Lobe-like projection with some crenulation on the border juxtaposed the third and fourth joints. Fourth joint much thinner and longer than the proximal joints, about as long as the second and third joint combined. Apically with a single long sclerotized spine (spine A) on posterior surface, basally with two non-sclerotized spines (spines B). Spination sometimes variable within individuals, especially on the fourth joint. Distally with fringe of thick, long hairs (Figs. 9, 10, 38, 59). *Posterior telopods*: Syncoxite mesally with lobe-like projections, termed inner horns (IH). Tips of inner horns (IH) with apical thorn and patch of hairs; terminal portion of inner horn bent posteriorly more than 90°. Subanal lobe densely covered with hairs (Figs. 11, 56). The 2nd joint forms an immovable finger, the third joint forms a movable finger. Three characteristic non-sclerotized spines on the inside of immovable finger, spaced at ⅓ intervals. Small triangular non-sclerotized lobe next to most proximal spine. Stout tip of immovable finger hook-shaped. Posterior face of movable finger with several sclerotized ridges.

Variation.— Members of *Sphaeromimus* are small in comparison to *Zoosphaerium*, the latter can reach a length of 100 mm (e.g., *Z. hippocastanum*), but moderate in size when compared to others in the order Sphaerotheriida. The number of stridulation ridges on the female washboard is correlated with the length of the individual, with three ridges on each side in the smallest females of *Sphaeromimus splendidus* sp. nov. and up to five ridges in the largest females. The number of ridges on each side of the washboard may vary in the same specimen.

Natural history, behavior.— Life observations of the two newly described species revealed that the first pair of legs is not used when walking on flat ground. The first pair of legs is held up, above the ground and next to the head. Upon encountering an obstacle such as a leaf or twig (personal observations, senior author), the first pair of legs touches the obstacle. The first leg differs morphologically from the remaining legs by having fewer ventral spines and lacking the typical apical spine. The 3rd–21st leg pair show identical characters with little variation, even in the same leg pair, regarding to the number of ventral spines and length of the claw.

Living animals of *S. splendidus* sp. nov. and *S. inexpectatus* sp. nov. seem to avoid climbing on steeply inclined twigs. When lightly touched while on branches the animals quickly roll up and drop down. Haacker and Fuchs (1972) reported a different behavior from apparently arboreal species observed in South Africa: when touched while sitting on a branch, the animals coil up the head and anterior body, but hold on firmly to the branch using the posterior legs. Only after repeated and aggravated disturbance the animals roll up and drop from the branch. One of the authors (T.W.) observed identical behavior as described by Haacker and Fuchs (1972) in one *Zoosphaerium* species found in Sainte Luce and Mandena, where they co-occur with the *Sphaeromimus*-species. This *Zoosphaerium* species was sometimes also found up to 250 cm high on trees and shrubs, feeding on the trunk. The behavioral differences may indicate different ecological niches for these sympatric sphaerotheriid species.

Discussion.— Currently, too few specimens are known to evaluate sexual dimorphism with

regards to the number of sensorial cones on the antennae as is known to occur in other sphaerotheriid genera (Verhoeff 1928: 791). Regenerated antennae were observed in some specimens. In these, the number of sensorial cones was reduced.

The black locking carinae on the inside of the anal shield show a central invagination in some specimens, which may indicate a fusion of originally two separate carinae. Verhoeff hypothesized that the anal shield of sphaerotheriids results from a fusion of at least two segments, the 13th segment and the telson (Verhoeff 1928:448, Bitelotergit). The characteristics of the carinae described here represent further support for this notion.

Species-specific characters found on the endotergum have also been reported from the South African genus *Sphaerotherium* (VandenSpiegel et al. 2003).

The distribution of the here observed toothed ridge on the femora of all walking legs within the order is currently unknown, it may have been overlooked by other authors (Silvestri 1917: figs. 5-10 and 17, Jeekel 1986, fig. 4). This ridge is present in all Malagasy sphaerotheriids examined to date by the senior author. Because of the rarity of female specimens, the vulvae were not dissected. Thus, the exact form of the cyphopod sclerites cannot be illustrated here.

The movable finger of the chela of the posterior telopods carries sclerotized ridges on its posterior surface. DeSaussure and Zehntner (1902) suggested these to represent another stridulation organ (Figs. 11–12, 35–36, 56–57). Haacker (1969:455) and VandenSpiegel et al. (2003) describe a similar feature in the South African *Sphaerotherium* and suggest that it may provide a better grip on the female legs during mating and we agree with this suggestion. The lobe-like projection on the 2nd joint of the anterior telopods with its small crenulations may serve a similar purpose. The function of the inner horns of the syncoxite of the posterior telopods is uncertain. It can be suggested that the big spine on the inner horn of the syncoxite is used to open the female vulvae or to transfer the sperm, while the posterior and anterior telopods hold the female. Unfortunately, matings have been reported for only one sphaerotheriid species (Haacker 1968, 1969, 1974) who mentioned transfer of a spermatophore with the male legs. His observations appeared to indicate that females take the spermatophore into their mouths shortly after transfer of the spemathophor. However, dissections of the entire male and female head and SEM studies of the mouth parts revealed no special structure in the male mouth parts for sperm transfer and no visible sperm bag in the female's head.

Conservation.— The two new species were found in two of the four remaining small patches of the southern littoral rainforest, in Mandena (1,103 ha, 160 ha slated as conservation area) and Sainte Luce (1,947 ha; Ramanamanjato et al. 2002, Vincelette et al. 2003). More field collecting in other areas may reveal other species of this interesting genus. Considering the fast destruction of the last isolated remaining forest patches (e.g., Green and Sussman 1990) and the endemism of the here described new *Sphaeromimus* species in Madagascar, new studies in other areas of the island are urgently needed.

Sphaeromimus musicus (DeSaussure and Zehntner, 1897)

Figs 1 – 27

Sphaeropoeus musicus DeSaussure and Zehntner, 1897 (publication of figure).
Sphaeromimus musicus, Saussure and Zehntner 1902 (publication of description).— Jeekel 1999 (lists species name) — Enghoff 2003 (lists species name).

Material examined.— Type material: Male holotype; Madagascar, Province: unknown, coll. A. Grandidier, MNHN, CH038, vidi, without telopods, specimen figured in atlas published 1897, plate 4, figure 1 a-e. Non-type material: 16 males, 3 females. Madagascar, Province: Toliara, coll. RNI Andohahela, par-

cel II, camp 6, ~120m NN, 24°49.0′S 46°36.6′E, 7-15.XII.1995, leg. S.Goodman, 2 males, 1 female; FMNH 5378. 2 males; FMNH 5372. 1 male; FMNH 5409. 1 male, pitfall trap 16-18; FMNH 5407. Province: Toliara, 1 male coll. Foret Analavelona, mid altitude forest with western and eastern elements, ~1050m NN, 9-15.III.1998, 22°40.7′S 44°11.5′E, leg. S. Goodman, 1 male; FMNH 5439. 2 males; FMNH 5427. Province: Toliara, coll. RP Berenty, Foret Bealoka, Mandrare River, gallery forest; ~35m NN, 24°57′25″S 46°16′17″E; 3-8.II.2002, leg. B.L. Fisher et al., 5 males; 2 females, BLF 5315; CAS. 2 males, BLF 5314; CAS.

Diagnosis.— *Sphaeromimus musicus* can be most easily distinguished from any other Malagasy sphaerotheriid by its unique coloration and pattern (Fig. 13), which identifies the species unambiguously. The body is orange, with an irregular black pattern near the posterior margin of each tergite. Each of the paratergites wears a median distinct thick black stripe. *S. musicus* is markedly more hairy than the other species of the genus, with hairs covering the head, legs, gnathochilarium, sternites and anal shield (Figs. 1–2, 4, 14–15). The anterior paratergite depressions carry an elongated patch of hairs on each. The body is less highly arched than in *S. splendidus* sp. nov. The coxal lobes of the walking legs are only weakly developed, but somewhat bigger than in *S. inexpectatus* sp. nov. (Fig. 2). Remarkable is also the high number of over 75 sensual cones (Fig. 21) on the last antennomere, which is much higher than those of *S. splendidus* sp. nov. (Fig. 43). The female washboard (Fig. 7) and the male harp (Fig. 8) are the biggest known in all Malagasy sphaerotheriids, with the highest number of stridulation ridges in the genus *Sphaeromimus*. The shape of the female operculum is unique and shorter in *S. musicus* than in the other species of the genus. Its mesal margin is more strongly developed than in its congeners (Fig. 5). The lower part of the inner plate (IP) of the female vulvae is not sclerotized and carries some triangular black spines. Molar plate process of the mandible with a single step (Fig. 17). In *S. musicus*, the endotergum features a distinct band of flattened nodules between the marginal bristles and the internal area covered with short spines and hairs (Fig. 17).

Description.— Body length: 17.2–34.5; width of thoracic shield: 13.3–17.6; height of thoracic shield 7.5–10.1.

Habitus: In general, the tergites of this species seem to be higher than in most other Sphaerotheriida, with the exception of *Sphaeromimus splendidus* sp. nov.

Coloration: body orange, with irregular black pattern near the posterior margin of each tergite. Each paratergite with a distinct thick black stripe, thoracic shield with even thicker black stripe, collum mostly black. Anal shield almost completely black (Fig. 13); head, antennae and legs orange-red. In alcohol, pattern and coloration, especially orange and red, are lost over time, either through exposure to light and/or alcohol; black stripe may fade completely, the black pattern becomes very irregular. The illustrated specimen in the original description shows this loss of coloration clearly. For this study, we examined a number of specimens in different stages of coloration and pattern loss, from specimens featuring almost lifelike color and pattern to the stage illustrated by DeSaussure and Zehntner (1897).

Head: with numerous hairs and setiferous pits mostly around the clypeus and lateral of the eyes. Some long, isolated hairs around the eyes and more distributed over the rest of the head. Posterior margin of the head towards the collum with dense field of very small hairs (Fig. 14).

Antennae: shape as given in genus description. Length of antennomeres: 1>2>3=4=5<6; 6th antennomere being broadest and longest (Fig. 20), flat, reaching broadest point near the middle and does not taper towards the sensual plate, with up to over 75 sensual cones (Fig. 21).

Mouth parts: *mandible* with six pectinate lamellae; number of teeth of pectinate lamellae declining from apical to proximal (Fig. 19). Molar plate process with a sharp single step near the apical border (Fig. 18). *Gnathochilarium* ventrally with many hairs on the lamellae linguales. Field of four sensorial cones, three grouped together, the fourth displaced towards posterior margin,

located laterally of the palpi (Fig. 16). *Epipharynx* as in the genus description.

Collum: anterior margin with two rows of isolated long hairs, posterior margin only with few isolated hairs, rows of hairs of the endotergum visible.

Thoracic shield: with an area of numerous thick hairs on the concave lateral extension ('Brustschildgruben' *sensu* Verhoeff) towards the marginal rim. Anterior rim of the lateral extensions broad (Fig. 1).

Tergites: posterior margins of tergites three to seven with a visible fringe of short hairs, which originates from the endotergum. The anterior paratergite depressions of the tergites four to ten are densely covered with hairs, anterior paratergite depressions of the anterior tergites with several ridges each. Anterior paratergite depressions of tergites 11 and 12 also with pads of dense hair, but ridges not visible in intact specimens. Tips of posterior margins of paratergites project posteriorly. The endotergum features a distinct band of flattened nodules between the marginal ridge and the internal area covered with short spines and hairs (Fig. 17). *1st Sternite:* lobe long, reaching beyond the length of the coxa, covered with many long hairs and curved towards the leg pair (Fig. 4). The upper margin is smoothly rounded and completely covered with individual long hairs, lower margin hairless (Fig. 4).

Anal shield: rounded, neither bell-shaped nor tapered, in males there is a weak invagination not seen in females and less distinct than in the South African genus *Sphaerotherium* (Fig. 1:AI). The anal shield carries on both sides a black locking carina, sloping towards the posterior end of the anal shield (Fig. 3). The locking carinae in this species are well-developed, but narrow and of medium length compared to other species.

Legs: tarsi of leg pair one and two with only four ventral spines and only weakly curved claws. Claws of the tarsi of following legs are curved wearing 12–14 ventral spines. Ninth pair of legs with a small lateral lobe and many small black triangular spines (Fig. 2). Coxae of all legs at the inside margin densely covered with many long hairs, also on the following leg joints at the inside margin some very long, isolated hairs.

Female sexual characters: second pair of legs with coxal lobe. Operculum (Fig. 5:O) of vulvae very broad and long, reaching ⅓ of the prefemur length. Mesal section of operculum drawn out apically and longer than lateral section. Center of operculum without indentation (=not subreniform), lower margin straight. Exterior plate (Fig. 5:EP) of vulvae long and broad, its anterior margin reaches around the base of the operculum. Inner plate (Fig. 5:IP) not as long as exterior plate, anterior margin of former ends below base of operculum. Posterior margin of inner plate not sclerotized, sloping lower than exterior plate, with short, triangular black spines (Fig. 5).

Subanal plate rounded, center of anterior margin with a broad shallow invagination. The washboard with six strong, symmetrical stridulation ribs which end just in front of the anterior margin. Subanal plate divided by central suture not reaching anterior and posterior margins of subanal plate (Fig. 7).

Male sexual characters: second pair of legs with a pronounced coxal lobe (Fig. 6). Anal shield with a weak invagination (Fig. 1:AS). *Anterior telopods*: first joint with a large stridulation harp and 5 stridulation ridges (Fig. 8), posterior side of second joint with a lobe-like projection, which reaches the 4th joint (Fig. 9). On its inside face two long, thin non-sclerotized spines (Figs. 10:G–H). The outside face of the lobe carries a patch of very small (sensorial) hairs (Fig. 9:H). The third joint is short and slightly invaginated towards the lobe of the second joint. Near the invagination insert two short (E) and one longer thin non-scletorized spine (F) (Figs. 9:E–F). The 4th joint carries basally a low knob (C) and a lateral non-sclerotized thin spine (D) (Figs. 9:C–D). The apical portion of the 2nd joint lobe is juxtaposed the low basal knob of the 4th joint (Figs. 9–10). *Posterior telopods*: telopod syncoxite densely covered with hairs. Outer surface of 2nd joint basal-

ly with hairs, apically hairless. Stout tip of immovable finger hook-shaped. Chela without species-specific characters, movable finger with genus-specific dentition and row of crenulated teeth. The opposite finger (2nd joint) features crenulations juxtaposed to the crenulated teeth of the movable finger. Base of movable finger laterally with some long hairs, more densely towards the outer margin, apical section with a few sensorial hairs (Fig. 22).

Distribution and ecology.— According to current collection records, *S. musicus* appears to be restricted to the southwestern region of Madagascar. To date, *S. musicus* is known from three localities, indicating a wider distribution range than some other sphaerotheriid species on Madagascar, e.g., *S. inexpectatus* sp. nov. and *S. splendidus* sp. nov. *Sphaeromimus musicus* was collected in gallery forests as well as in over 1,000 m elevation. It is remarkable that no specimens of this species were found in the spiny dry forest so widespread in its range, but the species appears to be restricted to semi-humid habitats such as gallery forests. The species was not found among other sphaerotheriid material, e.g., of the genus *Zoosphaerium*, collected in the eastern Hylaea areas or the western dry-deciduous forest. Collections took place during the wet season, December, February and the first half of March. Members of the genus *Zoosphaerium* were found at all three sites (Fig. 65) from which *S. musicus* were collected. No eggs were found in a dissected female collected during the wet season (Dec. 7–15, 1995 in RNI Andohahela, parcel II). It is unknown whether this species is active in the dry season.

Conservation.— The currently fragmented distribution of *S. musicus* is most likely the result of the continuing destruction of the natural vegetation. Habitat protection is vital for the survival of highly endemic species such as the type species of the genus *Sphaeromimus*.

Discussion.— Males and females in Sphaerotheriida molt after maturity (pers. obser.). Ontogenetic changes of characters described above have not been investigated to date, e.g., it is possible that the number of stridulation ridges increases with the age and size of the animal. This seems to be the case in females, the number of stridulation ridges on the male harp remain constant (Table 1). The small size of the vulva in this species is remarkable when compared to the relatively larger female vulvae in the much smaller females of *S. splendidus* sp. nov. and *S. inexpectatus* sp. nov.

Table 1. Variation in *S . musicus*. * indicates specimens used for drawings and SEM; m: male; f: female; TS w: width of thoracic shield; SR: number of stridulation ridges of harp in males and washboard in females on left/right body side.

Sex	*TS w*	*SR*	*Location*
m*	17,0	5/5	RNI Andohahela, parcel 2
m*	16,0	5/5	RNI Andohahela, parcel 2
f*	14,5	6/6	RNI Andohahela, parcel 2
m	17,4	5/5	RNI Andohahela, parcel 2
m	15,8	5/5	RNI Andohahela, parcel 2
m	17,0	5/5	RNI Andohahela, parcel 2
m	16,5	5/5	RNI Andohahela, parcel 2
m	15,9	5/5	Foret Analavelona
m	15,4	5/5	Foret Analavelona
m	15,6	5/5	Foret Analavelona
m	17,4	5/5	RP Berenty
m	16,7	5/5	RP Berenty
m	16,7	5/5	RP Berenty
m	16,7	5/5	RP Berenty
m	13,3	5/5	RP Berenty
f	16,2	8/8	RP Berenty
f	15,5	7/8	RP Berenty
m	17,6	5/5	RP Berenty
m	16,5	5/5	RP Berenty

Sphaeromimus splendidus **sp. nov.**
Figs 28–49

Material examined.— Type material: 1 female holotype; paratypes: 1 male; 3 females, 1 male immature, coll. Madagascar, Province: Toliara: Sainte Luce, littoral forest, 24°47′S 47°10′E; 08.IV.2003, leg. Wesener; FMNH 6702, 6703. 1 female (mature), identical collecting data; CAS. Other material examined: 2 males (immature), 2 females (immature), coll. Madagascar, Province: Toliara: Sainte Luce, littoral forest;

24°47′S 47°10′E, 06.04.2003, leg. Wesener, 2 juvenile, (width of thoracic shield: 3.4 mm, 2.9 mm; body length 7.6 mm, 7.0 mm), same collection data; vouchers, deposited at the Université Antananarivo.

Diagnosis — *S. splendidus* is distinguishable from other *Sphaeromimus* species by its completely black coloration and tergites with a satin sheen. This species is almost hairless, with only a few individual hairs on the anterior paratergite depressions and on the thoracic shield (Figs. 28–29). The body is more highly arched than in other *Sphaeromimus*-species. The coxal lobe is very long and well-developed which is one of the main characters by which this species can be distinguished from *S. musicus* and *S. inexpectatus* sp. nov. (Fig. 33). Remarkable is also the small number of only 20–45 antennal cones and the 6th antennomere (Fig. 43) is very slender. The male anterior telopods differ from the telopods in *S. musicus* by possessing a small pointed process on the anterior side of the first joint, reaching the 3rd joint. The operculum of the vulva reaches over the middle of the prefemur; its anterior margin is well rounded. The black locking carinae of the anal shield are shorter than in the other two species. The molar plate process of the mandible possesses one small and one big step (Fig. 40). The endotergum features only one row of marginal bristles and unique, rounded crenulations between the marginal ridge and the internal area, which is covered with short spines and hairs (Fig. 44).

Description.— Body length up to 23.6; width of thoracic shield: 8.2–11.8 (mature); height of thoracic shield up to 6.5.

Habitus: In general, the tergites of this species seem to be higher than in other Sphaerotheriida and higher than in all other species of this genus (Figs. 28–29).

Coloration: The body is shiny black. Smaller specimens are crème-white with only a black posterior margin at each tergite. As the animals grow the black margins on the tergites expand until the tergites are completely black. Head and collum brown, antennae olive-blackish, but antennomeres five and six remarkably lighter in color. Legs also olive-blackish, but apically lighter in color.

Head: with numerous hairs and setiferous pits mostly around the clypeus and lateral of the eyes. Few long, isolated hairs around the eyes and distributed over the rest of the head. Posterior margin of head towards the collum hairless (Fig. 39). Field of little crenulated teeth near the antennal socket with one small spine (Fig. 46).

Antennae: shape as given in genus description. Length of antennomeres: 1>2>3=4=5<6. Sixth antennomere being longest (Fig. 42), flat, reaching broadest point near the middle, but is not broader than other antennomeres. Tapering only slightly towards sensorial disc. Only 20 to 45 sensorial cones (Fig. 43).

Mouth parts: mandibular molar plate process with two steps near apical end (Fig. 40); with seven rows of pectinate lamellae, teeth short and broad; apical pectinate lamella with 18 teeth, number of teeth declining proximally (Fig. 41). *Gnathochilarium* ventrally with few hairs (Fig. 47), group of 4 sensorial cones located in a pit laterally of the palpi (Fig. 49). *Epipharynx* genus-like (Fig. 45).

Collum: anterior margin with some isolated long hairs, posterior margin only with few isolated hairs.

Thoracic shield: with only very few small hairs on the concave lateral extension of the thoracic shield towards the margin. Brim of anterior margin of lateral extension only slightly broader than remaining brim.

Tergites: hairless, shiny, only the anterior paratergite depressions and their anterior margins with very few short hairs. Anterior paratergite depressions of the anterior tergites with several ridges each. Anterior paratergite depressions of tergite 12 also with few hairs, but ridges not visible in intact specimens. Tips of posterior margins of paratergites project posteriorly, stronger in ter-

gites 9–11 (Figs. 28–29).

1st Sternite: lobe as long as coxa and curved to the leg pair. Upper margin smoothly rounded, isolated long hairs near the border. Rest of sternite hairless (Fig. 31: S = sternite).

Anal shield: rounded, neither bell-shaped nor tapered (Figs. 22–23). Anal shield with distinct, broad, but short black locking carinae on each side, sloping towards the posterior end (Fig. 30). Remarkable is a very small invagination at the middle of the carinae.

Legs: 9th leg pair with a pronounced coxal lobe and many small black triangular spines (Fig. 33). Tarsi of first two leg pairs with only three to four ventral spines and only weakly curved claws. Tarsi of following leg pairs curved, with 10–14 ventral spines and the apical spine. Coxae mesally with many dense long hairs; other podomeres with few, very long, isolated hairs.

Female sexual characters: second pair of legs with well-developed coxal lobe. Operculum (*O*) of vulvae: very broad and long, reaching over ½ of prefemur length; reaches its maximum length in center. Anterior margin without indentation (=not subreniform), lower margin with invagination in center. Exterior plate (EP) of vulvae long and broad, its anterior margin ends below base of operculum. Inner plate (IP) not as long as exterior plate, anterior margin of former extends below base of operculum (Fig. 32: O = operculum, IP = inner plate, EP = exterior plate).

Subanal plate rounded, center of anterior margin with a very broad shallow invagination. Washboard with three to five strong, symmetrical stridulation ribs, ending just in front of anterior margin. Washboard divided by central suture reaching anterior and posterior margins of subanal plate (Fig. 34)

Male sexual characters: second pair of legs with coxal lobe. *Anterior telopods*: first joint with a small harp and three stridulation ridges (Fig. 37) and on its posterior side with a very small projection, reaching the third joint. Posterior side of 2nd joint with a lobe-like projection, reaching 4th joint (Fig. 38: A = big spine; B = two small spines). Third joint short, 4th as described in genus description (Figs. 37–38). *Posterior telopods*: telopod syncoxite nearly hairless. Chela without species-specific characters, movable finger with genus-specific dentition and row of crenulated teeth. Opposite finger (2nd joint) features crenulations juxtaposed the crenulated teeth of the movable finger. Base of movable finger laterally with some hairs. Stout tip of immovable finger hook-shaped (Figs. 35–36). Immature males with bud-shaped anlagen (primordia) in the place of telopods as in mature male.

Distribution and ecology.— Some females collected in the beginning of April were carrying up to eight eggs, suggesting that the breeding season was in progress. Assuming a single annual breeding season and collecting adult egg-carrying females and juveniles with 19 leg pairs at the same time suggest that the adults are at least 2 years of age.

So far this species of *Sphaeromimus* was collected only from a fragment of littoral rainforest on sand in Sainte Luce. This particular patch of littoral rainforest is virtually undisturbed and may represent the best preserved of all four still existing southern littoral forest patches (Dumetz 1999; Vincelette et al. 2003; deGouvenain and Silander 2003). Juveniles and adults could be found in thick (30–80 mm) leaf litter, containing mostly big leaves of trees. The leaf litter was wet and did contain also a large numbers of Spirostreptida, Isopoda, winged Blattodea, Diplura and Collembola. In this assemblage, the giant pill-millipedes were the biggest arthropods found. This species was found together with two species of the genus *Zoosphaerium* (description in progress) one of which occurs also in the littoral rainforest in Mandena and in the eastern lowland rainforest. The second *Zoosphaerium* species appears to be restricted to Sainte Luce. The forest patch of Mandena was intensively searched for 18 days without success for *S. splendidus* sp. nov. In addition, *S. splendidus* sp. nov. was not found in any other collection samples. These observations suggest that *S. splendidus* sp. nov. is endemic to the littoral forest patch of Sainte Luce. Also, with

regards to the isopod fauna and vegetation (Dumetz 1999), the littoral forests of Mandena and Sainte Luce, albeit separated by a distance of only 20 km, display distinct faunal and floral differences. Currently, both patches of littoral forests are separated by pseudosteppe with apparently little humus and soil arthropods (pers. observation). Maps showing forest distribution dating back to 1950 indicate that continuous forest vegetation disappeared before 1950. Lehtinen et al. stated 2003: "*At present, the landscape at Mandena and Sainte Luce is a series of littoral rainforest fragments in a matrix of extremely degraded anthropogenic sand-scrub. This barren sand-scrub is the result of previous forest clearing, burning, and attempts at cattle grazing and is presumably a hostile environment for forest-dwelling organism* (p. 1359)." Our studies are comparable with this suggestion: no pill millipedes or other soil arthropods were found in the sand-scrub, no humus layer is visible in the pseudosteppe. Actually, there are no geographic barriers between the Mandena's and Sainte Luce's littoral rainforest, such as rivers and hills, which in other cases often form borders of a millipede species ranges. The only difference between the two localities is the annual precipitation, with higher rainfall in Sainte Luce (Donque 1972).

Conservation.— The forest at Sainte Luce is subject to human impact and wood removal as one of us (T.W.) observed. Protecting this unique and still relatively pristine littoral forest should receive highest priority.

Discussion.— Coloration not suitable for field identification, since shiny black *Zoosphaerium* species occur sympatrically. The only male known also shows the juvenile coloration, but has fully developed telopods and thus is most likely sexually active.

Table 2. Variation in *S. splendidus* sp. nov. * indicates specimens used for drawings and SEM; m = male; f = female; TS w: width of thoracic shield; SR: number of stridulation ridges of harp in males and washboard in females on left/right body side. * small, bud-shaped anlagen (primordia) of telopods present.

Sex	status	TS w	SR
m	mature	8,0 (4th segment!)	3/3
f (type)	mature	11,8	5/5
f	mature	11,2	5/5
f	mature	9,0	4/5
f	mature	8,4	4/5
f	mature	8,2	4/5
m	immature	5,1	*
m	immature	4,7	*
m	immature	3,1	*
f	immature	6,2	4/4
f	immature	5,1	3/3
?	juvenil	3,4	–
?	juvenil	2,9	–

***Sphaeromimus inexpectatus* sp. nov.**
Figs. 50–63.

Type material.— 1 male holotype (width of thoracic shield: 7.3mm), 1 female paratype, in parts (width of thoracic shield: 6.8mm); Madagascar, Province: Toliara, Mandena; littoral forest; in leaf litter with small fruits, 24°57′15″S 046°39′22″E ; IV.2003; leg. Wesener; FMNH 6701.

Diagnosis.— Coloration unique in the genus, males of *S. inexpectatus* pink to red (Fig. 63). Species almost hairless, except for some isolated hairs on the anterior paratergite depressions and thoracic shield (Fig. 50). Sixth antennomere broader than in the other two *Sphaeromimus* species, with well over 70 antennal cones (Figs. 60–61).

Coxal lobes only weakly developed. Lobe-like projection at the 2nd joint of the anterior telopods protruding laterally and reaching the distal end of the 3rd joint (Fig. 58: F = one thin spine), a unique feature for this species. *Sphaeromimus inexpectatus* sp. nov. differs from *S. musicus* by the possession of a small process inserting on the anterior side of the first joint of the anterior telopods, extending to the 3rd joint. Very remarkable is the curved, hook-like end of the immovable finger of the posterior telopods (Figs. 56–57). The operculum of the vulva is large and extends

over the middle of the prefemur. Its anterior margin is well rounded. The black locking carina of the anal shield is longer than in the other two species (Fig. 52: AS = anal shield; PL = pleurite). External tooth of the mandible with one big and a second small step. The endotergum features only one row of marginal bristles, which are separated by a wavy marginal ridge from the intermediate area covered with short spines and hairs (Fig. 62).

Description.— Body length: circa 15; width of thoracic shield: 6.8 (f)–7.3; height of thoracic shield up to 4.5.

Habitus: In general, the tergites of this species seem to be lower than in all other species of this genus.

Coloration: body of mature male pink, posterior margin of each tergite with thin black line; immature female crème-white to reddish, posterior margin of each tergite with a broad, brown line. Head and collum in male type pink, anterior paratergite depressions gray to reddish; antennae and legs remarkably silver-gray to yellow.

Head: with numerous hairs and setiferous pits mostly around the clypeus and lateral of the eyes. There are some long, isolated hairs around the eyes and more distributed over the rest of the head. The posterior margin of the head towards the collum is hairless.

Antennae: shape as given in genus description; length of antennomeres: 1>2>3=4=5<<6, last antennomere as long as antennomeres 4+5 combined; last Antennomere flat and very broad (Figs. 60–61).

Mouth parts: mandibular molar plate process with one big and a second smaller step near the apical tip; with seven pectinate lamellae, 20 teeth in apical pectinate lamella, number declining proximally.

Collum: anterior margin with some isolated long hairs, posterior margin only with few isolated hairs.

Thoracic shield: with only very few short hairs on the concave lateral extension of the thoracic shield towards the marginal rim. Rim around anterior margin only slightly broader than around the rest of the thoracic shield.

Tergites: hairless with very few short hairs in the anterior paratergite depressions and with some more longer hairs on the anterior margin. Tips of posterior margins of paratergites do not project posteriorly (Fig. 50).

1st Sternite: lobe as long as coxae, with some isolated long hairs, curved towards leg pair, upper margin irregularly rounded with two invaginations (Fig. 53: S = sternite), a few isolated long hairs near the margin. Rest of the sternite hairless.

Anal shield: rounded, neither bell-shaped nor tapered. Anal shield with black locking carinae on each side, sloping towards the posterior end of the anal shield (Fig. 52: AS = Anal shield; PL = pleurite). The locking carinae in this species are well-developed and broad, remarkably longer than those of the other *Sphaeromimus* species. Locking carinae with distinct but very small invagination at the center.

Legs: the first leg pair with only three, the 2nd with four to five ventral spines and only weakly curved claws. Claws of the following leg pairs are curved. Coxal lobe at 9th leg pair very weakly developed, with many small black triangular spines (Fig. 51). Tarsi of remaining legs with 12-15 ventral spines and one apical spine (damaged in specimen). Coxae at mesal margin with many dense long hairs, also on following podomeres some very long, isolated hairs.

Female sexual characters: 2nd pair of legs without coxal lobe but with one black spine. Operculum (*O*) of vulvae very broad and long, reaching ½ of the prefemur length, maximum length in the center. Center of operculum rim without indentation (=not subreniform), lower margin with weak invagination in the center. Exterior plate (EP) of vulvae long and broad, its anterior margin

ends below the base of the operculum. Inner plate (IP) is not as long as exterior plate, anterior margin of former ends below base. (Fig. 54: O = operculum, EP = exterior plate, IP = inner plate)

Subanal plate rounded, center of anterior margin with a broad invagination. The washboard with three strong, symmetrical stridulation ribs, ending just in front of the anterior margin. 1st and 3rd ribs smaller than 2nd . Subanal plate divided by short median suture only in the center (Fig. 55).

Male sexual characters: 2nd pair of legs without a coxal lobe. *Anterior telopods*: 1st joint with small harp and three stridulation ridges (Fig. 58: F = one thin spine), posterior side of 1st joint with a small projection which reaches the 3rd joint. Lobe-like projection laterally on posterior side of 2nd joint reaching 4th joint (Figs. 58–59). 3rd joint short and slightly invaginated towards the lobe of the second joint, with one longer thin non-scletorized spine (F) juxtaposed the second joint lobe (Figs. 58–59: A = big spine, B = two small spines, D = small lateral spine, F = longer spine). *Posterior telopods*: Movable finger of chela with genus-specific dentition and row of crenulated teeth. The opposite finger (2nd joint) features crenulations juxtaposed to the crenulated teeth of the movable finger and also one non-slerotized spine on its anterior side (Fig. 56). Movable finger almost hairless. 2nd joint with some hairs on the immovable finger. Stout tip of immovable finger curved and hook-shaped (Figs. 56–57). Telopod coxa densely covered with hairs.

Distribution and ecology — So far this species of *Sphaeromimus* was collected only from a fragment of littoral rainforest on sand in Mandena. This particular patch of littoral rainforest is little disturbed, with 50–75% forest cover (QIT Madagascar forest map). The holotype was found in thin (5–30mm) dry leaf litter, containing mostly leaves and some tree fruits. A few winged Blattodea were found as well. A new species of genus *Zoosphaerium* (unpublished/in preparation), which occurs also in the littoral rainforest in Sainte Luce and in the eastern lowland rainforest, was common in this area (>300 mature and mostly immature where detected).

Body rings of spirostreptid and small sphaerotheriid tergites were found in a layer of arthropod remains around ant holes of a big red ant species. It is unknown how the ants are able to hunt these well-armored animals. Rolled up sphaerotheriids were placed near ants, but the ants showed no interest. A large *Zoosphaerium* specimen (34 mm long, 16 mm broad (2nd segment)) was put in a cage with one Carnivora: *Galidia elegans* inside, which was caught and kept at the Pepinière in Mandena. *Galidia* was able to detect the rolled up specimen, broke the tergites with a few bites of the lateral teeth and ate internal parts, ignoring the intestine tergite pieces. It is likely that *Galidia elegans* may represent a predator of pill millipedes, including *Sphaeromimus inexpectatus.* Predation of pill millipedes by mongoose was reported by Eisner and David (1969).

The female collected in the middle of April was carrying two eggs, suggesting that the breeding season was in progress. The forest patch of Mandena was intensively searched for 18 days during rain and at night without locating more specimens. This fact prompts us to suggest that *S. inexpectatus* is either a very rare species or was not active during the collection time. *S. inexpectatus* was not found in any other collection samples or in nearby littoral forest patches of Petriky and Sainte Luce. Additionaly it was not present in the collections of CAS, FMNH or in the huge collections of the MNHN. People living in the area are familiar with pill millipedes, calling them "Mia," but were not aware of this red-colored species. These observations may indicate that *S. inexpectatus* is endemic or now restricted to the littoral forest patch of Mandena. According to the isopod fauna and vegetation (Dumetz 1999), the littoral forests of Mandena are different from those of Petriky and Sainte Luce, albeit a distance of only 20–30 km separates these.

Conservation.— Currently, the observed patch of littoral forests is separated by pseudosteppe or *Eucalyptus* plantations with apparently little humus and soil arthropods (per. observation). In the past 50 years almost 73% of the original forest was destroyed (Vincelette et al. 2003). Currently, the small study area is efficiently protected by QIT Madagascar. It is however, uncer-

TABLE 3. Species separation in *Sphaeromimus*. No. = Number; gn = gnathochilarium; a.t. = anterior telopods; p.t. = posterior telopods; SR = stridulation ridges.

Character:	*Sphaeromimus musicus*	*Sphaeromimus splendidus* sp. nov.	*Sphaeromimus inexpectatus* sp. nov.
Tergite coloration:	orange with black pattern	black	pink
Body length:	up to 34.5 mm	up to 23.6 mm	at least 15 mm
No. of SR in female	7-Aug	5-May	3
No. of SR in male	5	3	3
antennal cones	up to 75	up to 45	up to 75
Sensorial cones lateral of gn-palpi	4, 1 displaced	4, all together	?
Surface of tergites	few hairs	bald	bald
Patch of hairs on the head towards the collum	present	absent	absent
Molar plate process of mandible	with 1 large step	with 2 steps	with 2 steps (2nd small)
No. of pectinate lamellae	6	7-Jul	7
No. of ocelli	>80	50–60	?
Coxal lobe of legs	weakly developed	strongly developed	nearly absent
Endotergum: marginal ridge	straight	straight	curved
Endotergum: flattened nodules	oval	rounded	rounded
Endotergum: No. of rows of marginal bristles	3-Mar	1–2	1
a.T. process of 2nd joint visible	only posterior of joint 3&4	only posterior of joint 3&4	posterior and lateral of joint 3&4
p.t.: 2nd joint	apical end stout	apical end stout	apical end hook-like

tain, whether the protected area is large enough to sustain viable populations of this species. The senior author noted the lack of old large trees in the area and wood removal by humans is ongoing.

DISCUSSION

The three species of *Sphaeromimus* are easily distinguished from each other, see Table 3. Jeekel (1974, Fig. 64 B) presented the most recent classification of the order Sphaerotheriida, while Hoffman (1976) and Mauriès (2001) modified Jeekel's classification of the sphaerotheriid family Sphaeropoeidae (Fig. 64 A). Jeekel employed characters found in the shape of the female vulva and the stridulation organs (harp in males, washboard in females) to separate tribes and subfamilies. The genus *Sphaeromimus* belongs to the family Sphaerotheriidae, sharing the main synapomorphy of its genera: basis of the vulval operculum embraced by the bursa (consisting of the exterior and inner plate, Fig. 64, character 1). Jeekel considers the presence of a female stridulation organ, the washboard (Fig. 64, character 2) as the synapomorphy for the subfamily Arthrosphaerinae, to which the genus *Sphaeromimus* is currently assigned. The other synapomorphy of the subfamily cited by Jeekel, the median protrusion of the bursa, is not present in *Sphaeromimus* (Fig. 64, character 3). In Jeekel's classification, *Zoosphaerium* and *Sphaeromimus*, the two Malagasy sphaerotheriid genera, are placed in the tribe Zoosphaeriini, based on the possession of the harp in the males (occurs in both genera, character 4). Jeekel also listed the shape of the subreniform

female operculum (character 5), as it occurs in *Zoosphaerium*, as an apomorphy of the tribe. However, now that females of *Sphaeromimus* are known, this latter apomorphy cannot be supported. Females of *Sphaeromimus* have a round operculum with a smooth edge.

Furthermore, *Sphaeromimus* shares characters with members of the Indian genus *Arthrosphaera*, currently placed by Jeekel (1974) in the tribe Arthrosphaerini of the Arthrosphaerinae. Such shared characters are: 6th antennomere flat and broad (cylindrical in *Zoosphaerium*, Fig. 64, character 8), and the four-jointed anterior telopods (Attems 1936, Fig. 64, character 9). Thus, males of *Sphaeromimus* share on the one hand a characters with the genus *Arthrosphaera* (characters 8 and 9) and on the other hand a character, the harp (character 4), with the genus *Zoosphaerium* (DeSaussure and Zehntner 1902; Pocock 1895). In *Sphaeromimus*, the washboard features a rather deep median groove (character 10) of variable length. The presence of the groove may indicate the fusion of two separate plates. In contrast, all *Zoosphaerium* species examined to date possess a completely fused subanal plate without a suture or groove. A groove is also present in at least one species of the Indian genus *Arthrosphaera*. Unfortunately, the form of the subanal plates are known for only few members of both genera. These morphological details indicate clearly that the current classification scheme (Fig. 64) lacks sufficient character support and that more characters are needed to define monophyletic clades within the Sphaerotheriida unequivocally.

Acknowledgments

The senior author gratefully acknowledges the support and advice by Prof. Dr. J.-W. Wägele. We thank the Direction des Eaux et Forêts and the Commission Tripartite for their authorization to carry out this work. QIT Madagascar Minerals and their environmental and conservation team headed by Manon Vincelette and Jean-Baptiste Ramanamanjato provided excellent support. The paper is part of the Accords de Collaboration between the Université d'Antananarivo (Dept. Biologie Animale and Anthropologie et Biologie Evolutive), QIT Madagascar Minerals and Hamburg University. The support by O. Ramilijaona and D. Rakotondravony is gratefully acknowledged. During fieldwork QIT Madagascar provided logistics support (arranged by J.B. Ramanamanjato). Collecting permits were arranged by Dr. O.Ramilijaona (Department de Biologie Animale, Université d'Antananarivo). Special thanks go to the Direction des Eaux et Forêts, Antananarivo for arranging collecting and export permits. The senior author conducted the fieldwork on an expedition organized by Prof. Dr. J.U. Ganzhorn (University of Hamburg). Expenses for the fieldwork were defrayed through personal funds. We thank Mr. Charles E. Griswold and Mr. Darrell Ubick (California Academy of Sciences) for the loan of material. Special thanks go to Dr. C. Schmidt (Ruhr-University Bochum) for continuous advice throughout the study. Ms B. Strack (Field Museum) assisted us during the preparation of the SEM images. We thank Drs. VandenSpiegel, Hamer and Ganzhorn for helpful suggestions on previous drafts of the manuscript. A one-month internship of the senior author at the Field Museum of Natural History and the work on the manuscript was supported by NSF grant DEB 97-12438 to P. Sierwald and W.A. Shear (Hampden-Sydney College, Virginia). A 20-day visit of the senior author at the Muséum National d'Histoire Naturelle to study the type collection and the undetermined material was supported by Synthesys grant FR-TAF-186. Special thanks go to J.-J. Geoffroy and L.E. Leoz for the organisation of this visit.

Literature cited

Attems, C. 1897. Myriopoden. *Abhandlungen herausgegeben von der Senckenbergischen Naturforschenden Gesellschaft* 23:473–536 + 4 Tafeln

ATTEMS, C. 1928. The Myriopoda of South Africa. *Annals of the South African Museum* 26:213–240.

ATTEMS, C. 1936. Diplopoda of India. *Memoirs of the Indian Museum* 11:136–195

ATTEMS, C. 1942. Neue Sphaerotheriden des Wiener Museums. *Annalen des Naturhistorischen Museums in Wien* 53 II:60–73; plates VII–IX.

CRAWFORD, C. S. 1992. Millipedes as model detritivores. *Berichte des Naturwissenschaftlich-Medizinischen Verein Innsbruck* 10:277–288.

CURRY, J.P. 1994. *Grassland Invertebrates*. Chapman and Hall, London, UK. 437 pp.

DE GOUVENAIN, R.C., AND J.A. SILANDER. 2003. Littoral Forest. Pages 103–109 *in* S.M.Goodman and J.P.Benstead, eds., *The Natural History of Madagascar*. University of Chicago Press, Chicago, Illinois, USA.

DESAUSSURE, H., AND L. ZEHNTNER. 1897. Atlas de l'histoire naturelle des Myriapodes. *In* Grandidier, *Histoire physique, naturelle et politique de Madagascar* 27(53): pls. 1–12.

DESAUSSURE, H., AND L. ZEHNTNER. 1902. Myriapodes de Madagascar. In Grandidier, *Histoire physique, naturelle et politique de Madagascar* 27(53): i – viii, 1 – 356, pl. 13, 14, 15.

DONQUE, G. 1972. The climatology of Madagascar Pages 87–145 *in* R.Battistini and G. Richard-Vindard, eds., *Biogeography and Ecology in Madagascar*. Monographiae Biologicae No. 21. The Hague, Netherlands.

DUMETZ, N. 1999. High plant diversity of lowland rainforest vestiges in eastern Madagascar. *Biodiversity and Conservation* 8:273–315

EISNER, J.C., AND J.A. DAVID. 1967. Mongoose throwing and smashing millipedes. *Science* 155(3762):577–579.

ENGHOFF, H. 1978. *Arthrosphaera* cf. *brandti* (Humbert), a giant pill-millipede found in Tanzania, probably introduced from Sri Lanka. *Revue Zoologique Africaine* 91(4):997–999.

ENGHOFF, H. 1983. Adaptive radiation of the millipede genus *Cylindroiulus* on Madeira: habitat, body size, and morphology (Diplopoda, Julida: Julidae). *Revue d'Ecologie et de Biologie du Sol* 20:403–415

ENGHOFF, H. 2003. Diplopoda, Millipedes. Pages 1617–1627 *in* S.M.Goodman and J.P.Benstead, eds., *The Natural History of Madagascar.* University of Chicago Press, Chicago, Illinois, USA and London, UK.

GANZHORN, J.U., P.P. LOWRY II, G.E SCHATZ, AND S. SOMMER. 2001. The biodiversity of Madagascar: one of the world´s hottest hotspots on its way out. *Oryx* 35(4):346–348.

GLAW, F., AND M. VENCES. 1994. *A Fieldguide to the Amphibians and Reptiles of Madagascar*, 2nd ed. Moos-Druck, Leverkusen, Germany. 480 pp.

GREEN, G.M., AND R.W. SUSSMAN. 1990. Deforestation history of the eastern rain forests of Madagascar from satellite images. *Science* 248: 212–215.

HAACKER, U. 1968. Sperma-Transport beim Kugeltausendfüssler. *Die Naturwissenschaften* 55(2):89.

HAACKER, U. 1969. Das Sexualverhalten von Sphaerotherium dorsale (Myriapoda, Diplopoda). *Zoologischer Anzeiger*, Supplement, (Verhandlungen der Deutschen Zoologischen Gesellschaft) 32:454–463.

HAACKER, U. 1974. Patterns of communication in courtship and mating behaviour of millipedes (Diplopoda). Pages 317–328 in *Symposium of the Zoological Society in London* No. 32.

HAACKER, U., AND S. FUCHS. 1972. Tree climbing in pill-millipedes. *Oecologia* 10:191–192.

HAMER, M.L., AND R.H. SLOTOW. 2002. Conservation applications of existing data for South African millipedes (Diplopoda). *African Entomology* 10; 1; 29–42

HOFFMAN, R.L. 1976. The systematic status of the diplopod genus *Rajasphaera* Attems, 1935. *Entomologische Mitteilungen aus dem Zoologischen Museum in Hamburg* 5:117–126.

HOFFMAN, R.L. 1980. *Classification of the Diplopoda*. Muséum d'Histoire Naturelle, Genève, Switzerland. 238 pp.

JEEKEL, C.A.W. 1971. Nomenclator generum et familiarum Diplopodorum: A List of the genus and family-group names in the Class Diplopoda from the 10th edition of Linnaeus, 1758, to the end of 1957. *Monografieen van de Nederlandse Entomologische Vereniging*, No. 5 Amsterdam, Netherlands. 412 pp.

JEEKEL, C.A.W. 1974. The group taxonomy and geography of the Sphaerotheriida (Diplopoda). Pages 41–52 in *Symposium of the Zoological Society in London* No 32

JEEKEL, C.A.W. 1986. Millipedes from Australia 10. *Beaufortia* 36(3): 35–50.

JEEKEL, C.A.W. 1999. A new pill-millipede from Madagascar, with a catalogue of the species hitherto described from the island (Diplopoda, Sphaerotheriida). *Myriapod Memoranda* 1:5–20.

Jenkins, P.D. 1993. A new species of Microgale (Insectivora:Tenrecidae) from eastern Madagascar with an unusual dentition. *American Museum Novitates* (3067):1–11.

Köhler, H.-R., and G. Alberti. 1990. Morphology of the mandible in the millipedes (Diplopoda, Arthropoda). *Zoologica Scripta* 19:195–202.

Lehtinen, R.M., J.-P. Ramanamanjato, and J.G Raveloarison. 2003. Edge effects and extinction prononess in a herpetofauna from Madagascar. *Biodiversity and Conservation* 12:1357–1370.

Mauriès, J.-P. 2001. Sur l'identité de *Zephronia hainani* Gressit, 1941, à propos de la description d'un nouveau *Prionobelum* (Diplopoda, Sphaerotheriida, Sphaeropoeidae) de Haïnan, Chine. *Zoosystema* 23(1): 131–142.

Mesibov, R. 1998. Species-level comparision of litter invertebrates at two rainforest sites in Tasmania. *Tasforests* 10:141–157

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403:853–858.

Pocock, R.I. 1895. Description of new genera of Zephronidae, with brief preliminary diagnoses of some new Species. *Annals and Magazine of Natural History* (zoology, botany and geology), ser. 6, 16:409–415.

Rabinowitz, P.D., M.F. Coffin, and D. Falvey. 1983. The separation of Madagascar and Africa. *Science* 220: 67–69.

Ramanamanjato, J.-P., P.B McIntyre, and R.A. Nussbaum. 2002. Reptile, amphibian, and lemur diversity of the Malahelo Forest, a biogeographical transition zone in southeastern Madagascar. *Biodiversity and Conservation* 11:1791–1807

Schaefer, M. 1990. The soil fauna on a beech forest on limestone: Trophic structure and energy budget. *Oecologia* 82:128–136.

Shelley, R.M. 2003. A revised, annotated, family-level classification of the Diplopoda. *Arthropoda Selecta* 11(3):187–207.

Silvestri, F. 1917. Specie di Sphaeroteridae delle regioni australiana e neozelandse a me note. *Bollettino del Laboratorio di Zoologia Generale e Agraria della R. Scuola Superiore d'Agricoltura in Portici* 12:61–85.

Sparks, J.S., and M.L.J. Stiassny. 2003. Introduction to the freshwater fishes. Pages 849–863 *in* S.M.Goodman and J.P.Benstead, eds., *The Natural History of Madagascar.* University of Chicago Press, Chicago, Illinois, USA.

VandenSpiegel, D. 2002. On the occurrence of *Sphaerotherium punctulatum* in Malawi (Diplopoda: Sphaerotheriidae). *Annals du Museum Royal Africa Central* (*Zoologique*) 290:171–174.

VandenSpiegel, D., S. I. Golovatch, and M. Hamer. 2003. Revision of some of the oldest species in the millipede genus *Sphaerotherium*, Brandt, 1833, (Diplopoda, Sphaerotheriida, Sphaerotheriidae), with new synonymies. *African Invertebrates* 43:143–181.

Verhoeff, K.W. 1927. Myriapoda: Diplopoda. Results of Mjöberg´s Swedish scientific expeditions to Australia 1910–1913. *Arkiv för Zoologi* 16(5):40–69; pl. 2.

Verhoeff, K.W. 1928. Diplopoda I. *Bronn's Klassen und Ordnungen des Tierreiches* 5(2.II):1–1071. Akademische Verlagsgesellschaft, Leipzig, Germany.

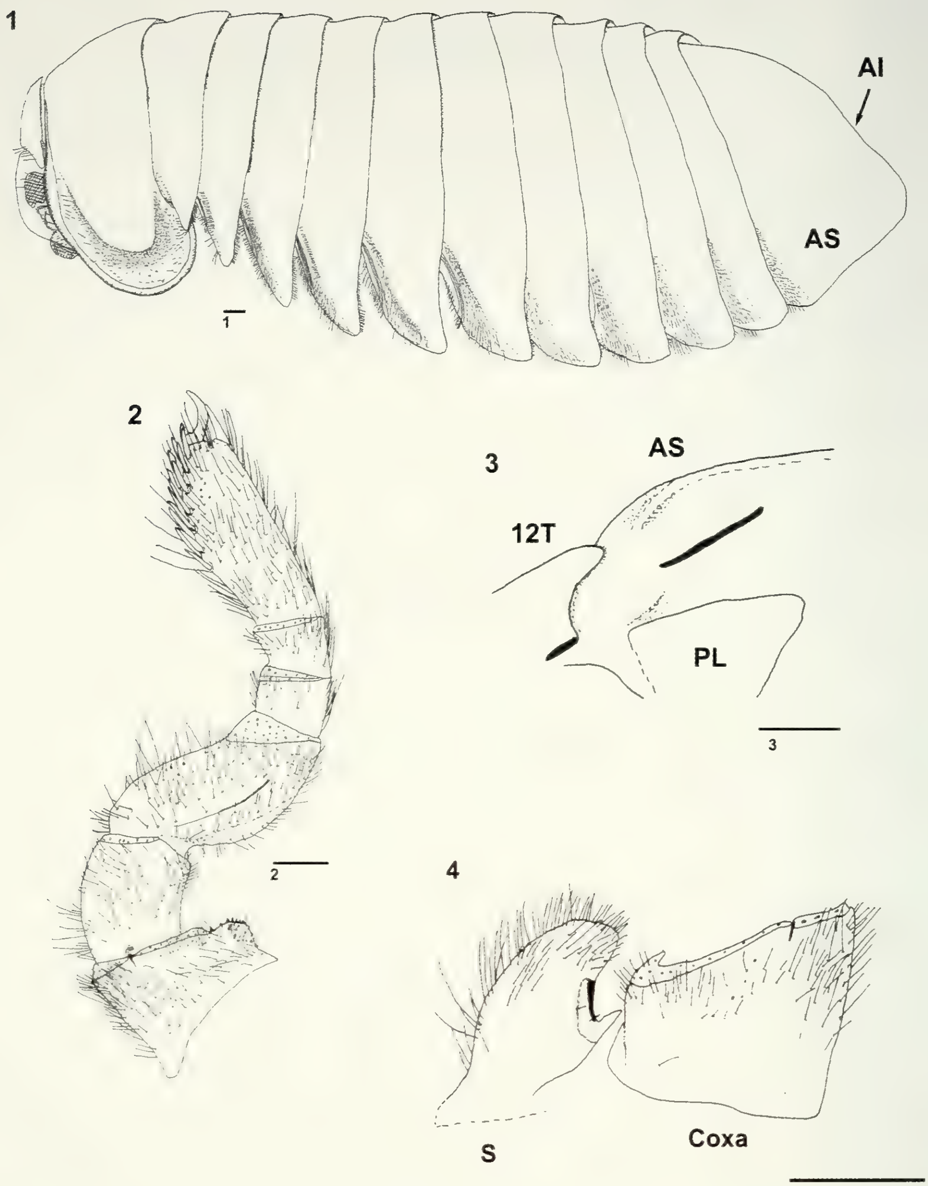
Verhoeff, K.W. 1932. Diplopoda II. *Bronn's Klassen und Ordnungen des Tierreiches* 5(2.II):1073–2084. Akademische Verlagsgesellschaft, Leipzig, Germany.

Vincelette, M., L. Randrihasipara, L., J.-B. Ramanamanjato, P.P. Lowry II, and J.U. Ganzhorn. 2003. Mining and Environmental Conservation: The Case of QIT Madagascar Minerals in the Southeast. Pages 1535–1537 *in* S.M.Goodman and J.P.Benstead, eds., *The Natural History of Madagascar*. University of Chicago Press, Chicago, Illinois, USA.

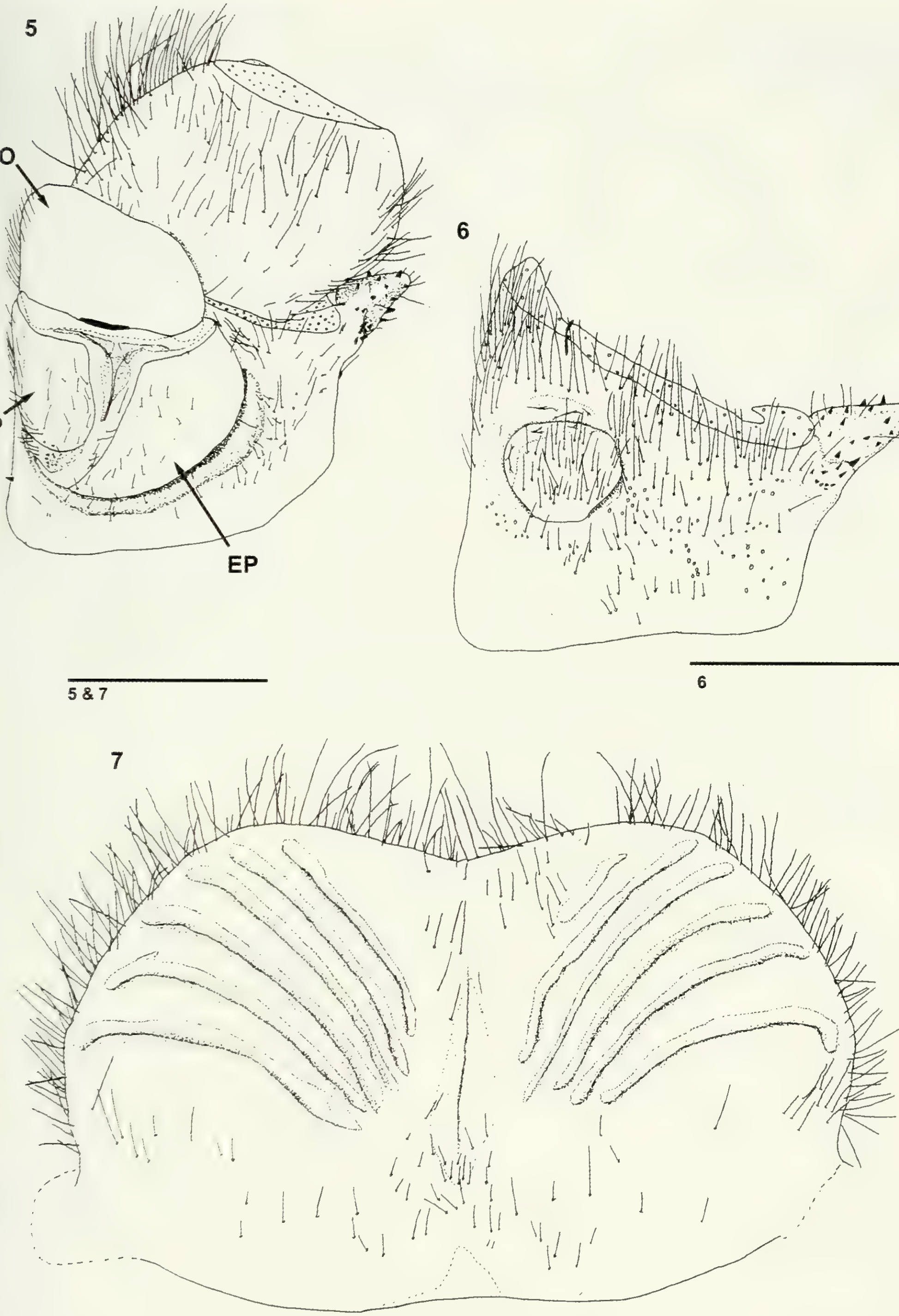
Wells, N.A. 2003. Some epitheses on the Mesozoic and Cenozoic paleoenvironmental history of Madagascar. Pages 16–34. *in* S.M.Goodman and J.P.Benstead, eds., *The Natural History of Madagascar.* University of Chicago Press, Chicago, Illinois, USA.

Wolters, V., and K. Ekschmitt. 1997. Gastropods, isopods, diplopods, and chilopods: neglected groups of the decomposer food web. Pages 265–306 *in* G. Benckiser, ed., *Fauna in Soil Ecosystems*. Marcel Dekker, Inc., New York, New York, USA.

ILLUSTRATIONS



FIGURES 1–4. *Sphaeromimus musicus*, male. 1: habitus; 2: left 9th leg, posterior view; 3: anal shield, dorsal view of black locking carinae; 4: 1st right sternite with coxa of 1st pair of legs. AI = invagination of anal shield; 12T = 12th tergite; PL = pleurite; AS = anal shield; S = sternite. Scale bars: 1 mm.



FIGURES 5–7. *Sphaeromimus musicus*, female and male. 5: 2nd left leg: coxa (female) with vulva; 6: 2nd left leg: coxa (male), posterior view; 7: washboard. O = operculum; IP = inner plate; EP = exterior plate. Scale bars: 1 mm.

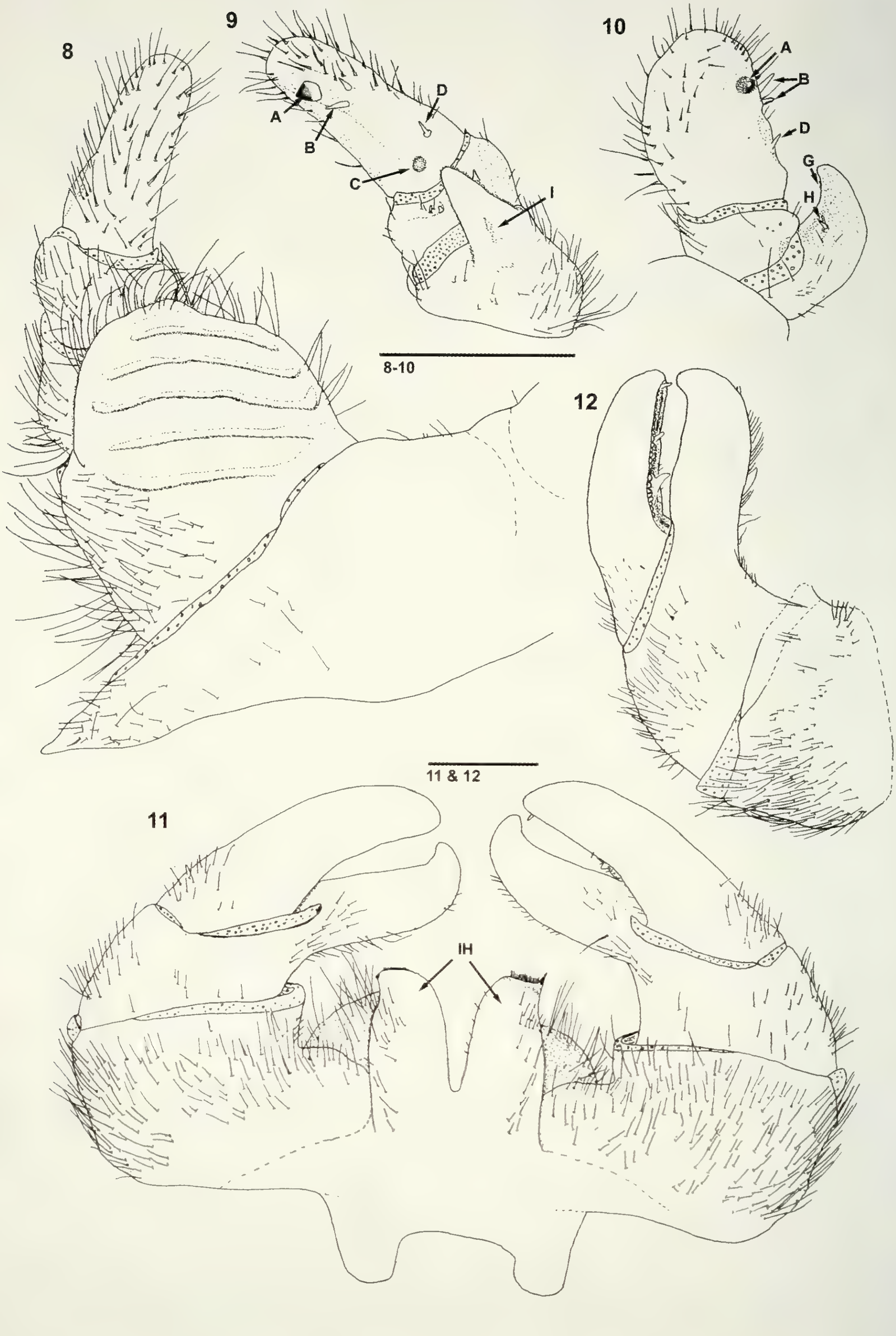

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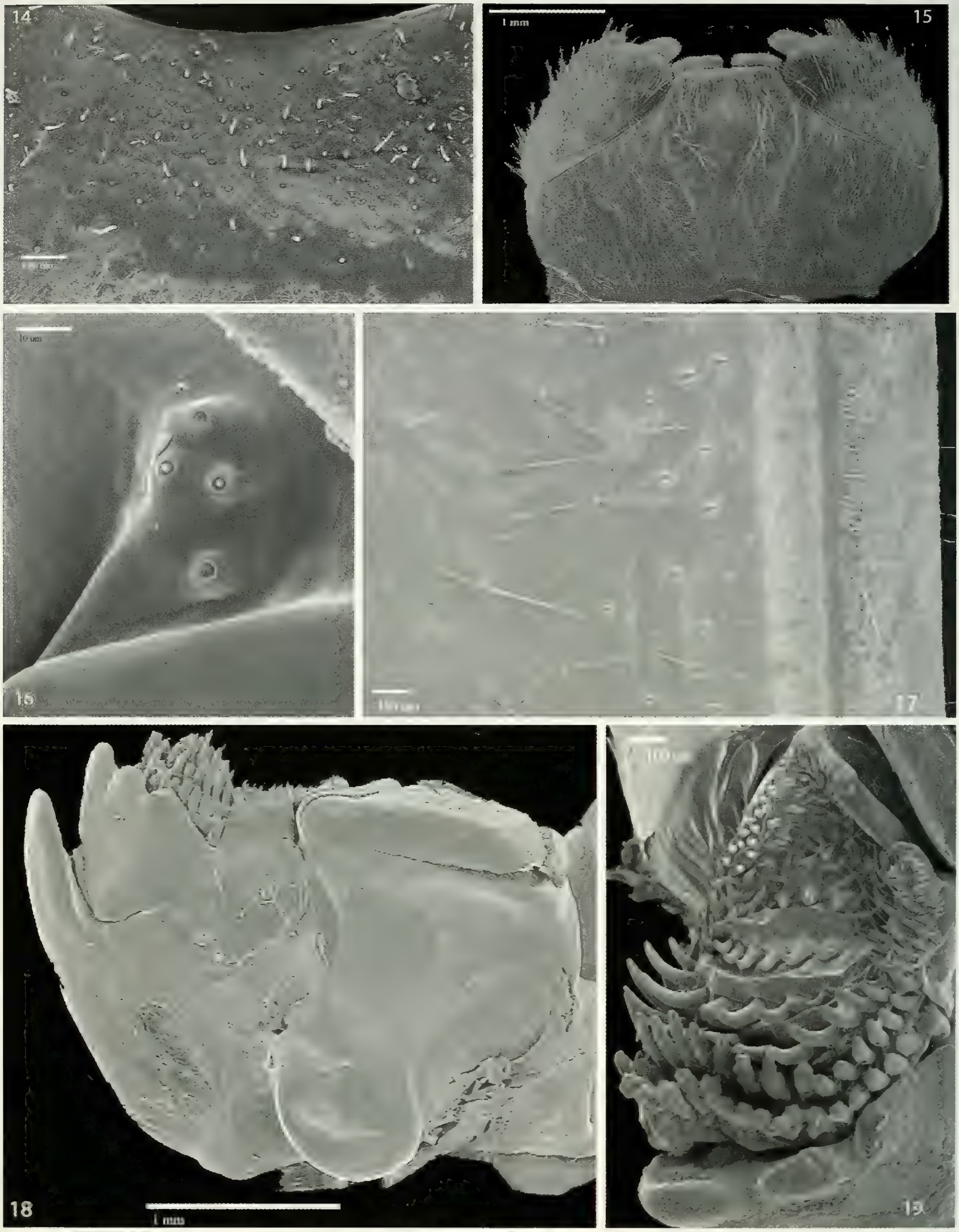
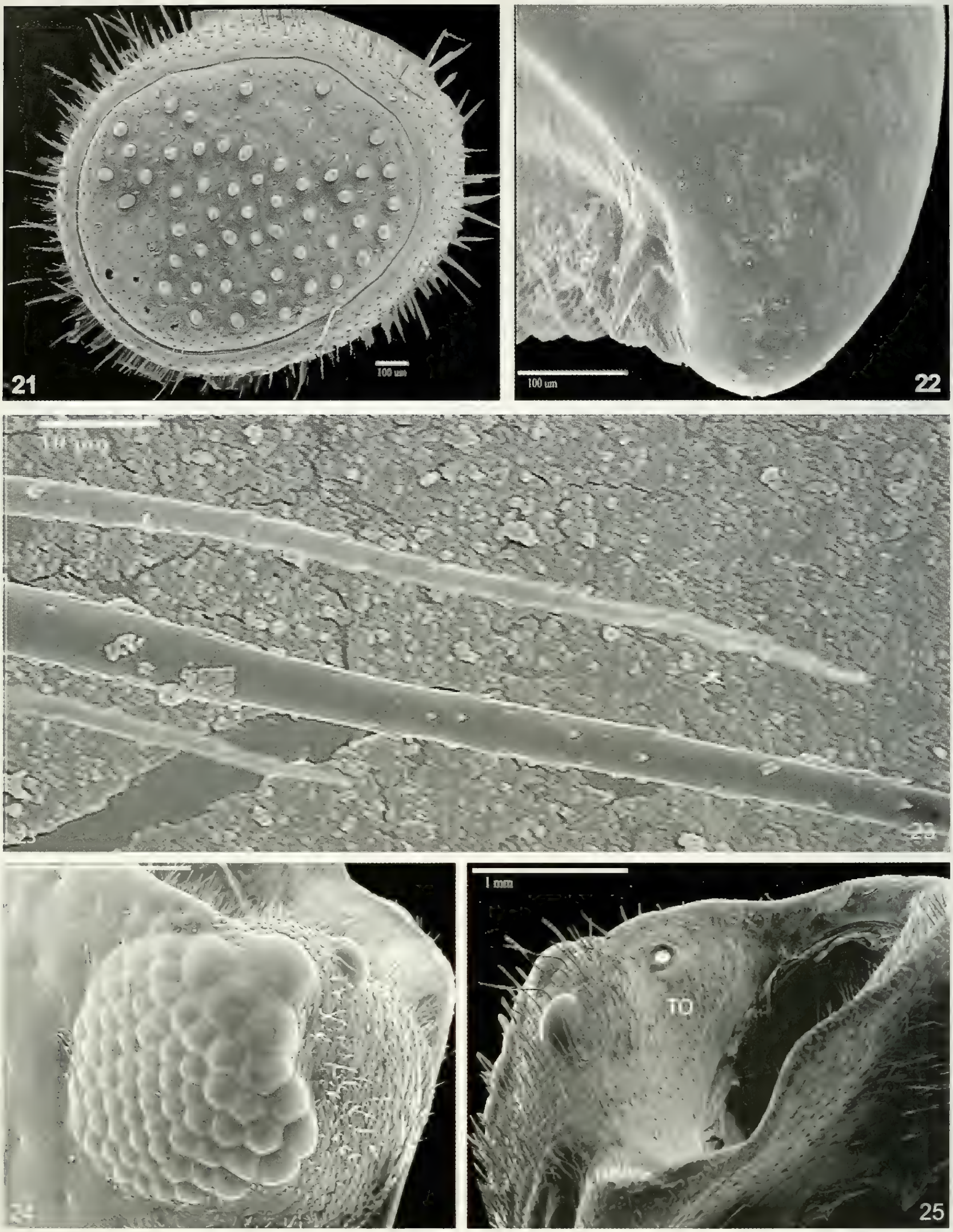
FIGURE 13 (above). *Sphaeromimus musicus*. Photo of freshly preserved male.

FIGURES 8–12 (left). *Sphaeromimus musicus*, male. 8: left anterior telopod, anterior view; 9: left anterior telopod, posterior view; 10: anterior telopod, lateral view; 11: posterior telopods, anterior view; 12: posterior right telopod, posterior view. A = 4th joint big spine; B = 4th joint 2 small spines; C = 4th joint knob; D = 4th joint 1 small lateral spine; I = 2nd joint sensorial hairs; G = 2nd joint lobe crenulation; H = 2nd joint lobe 2 spines; IH = inner horns. Scale bars: 1 mm.

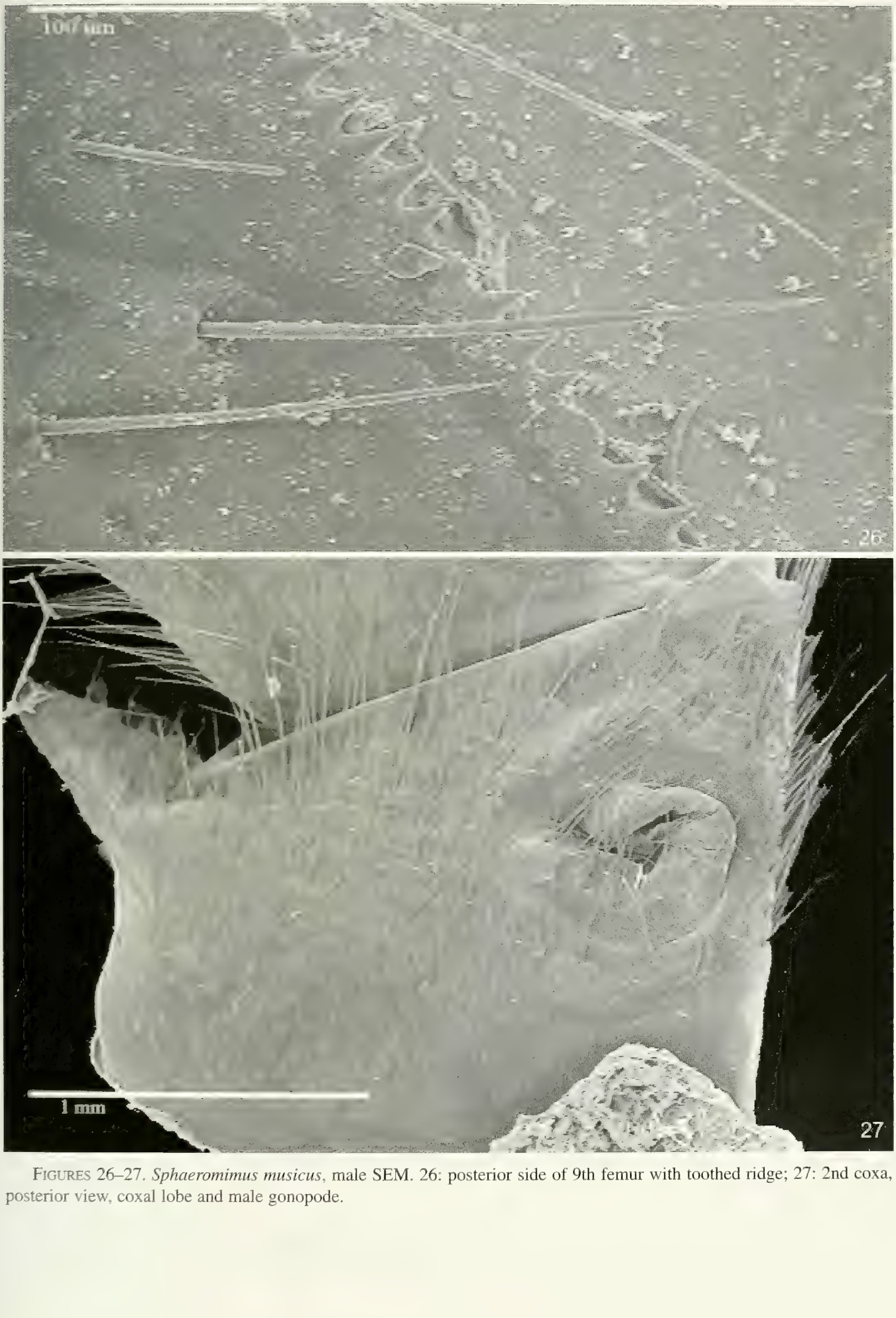


FIGURES 14–19. *Sphaeromimus musicus*, male SEM. 14: patch of hairs on head to collum; 15: gnathochilarium, ventral view; 16: field of sensorial cones lateral of palpi of gnathochilarium; 17: endotergum 18: right mandible, general view; 19: right mandible, pectinate lamellae.

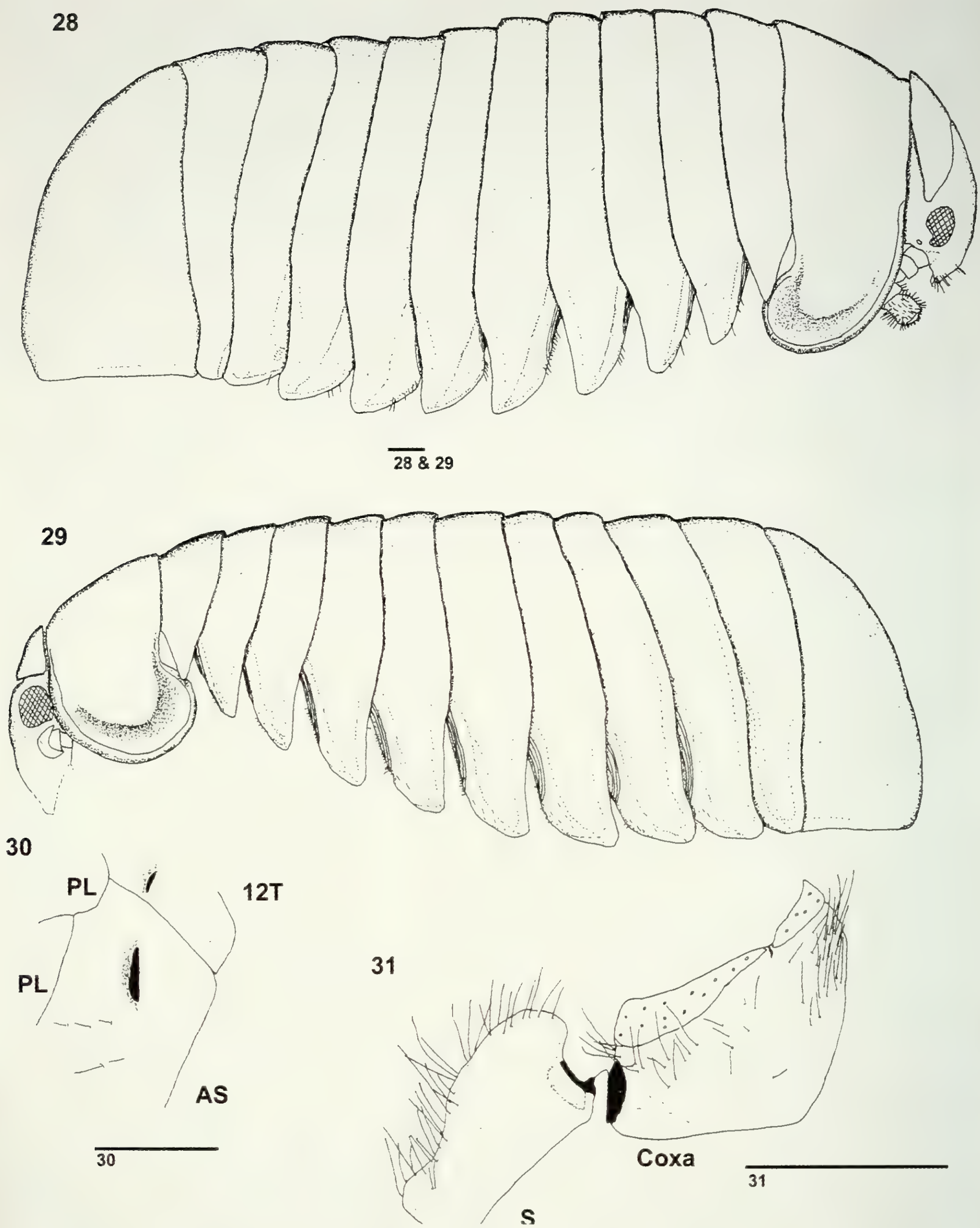
FIGURE 20. *Sphaeromimus musicus*, male SEM, antennae, lateral view.



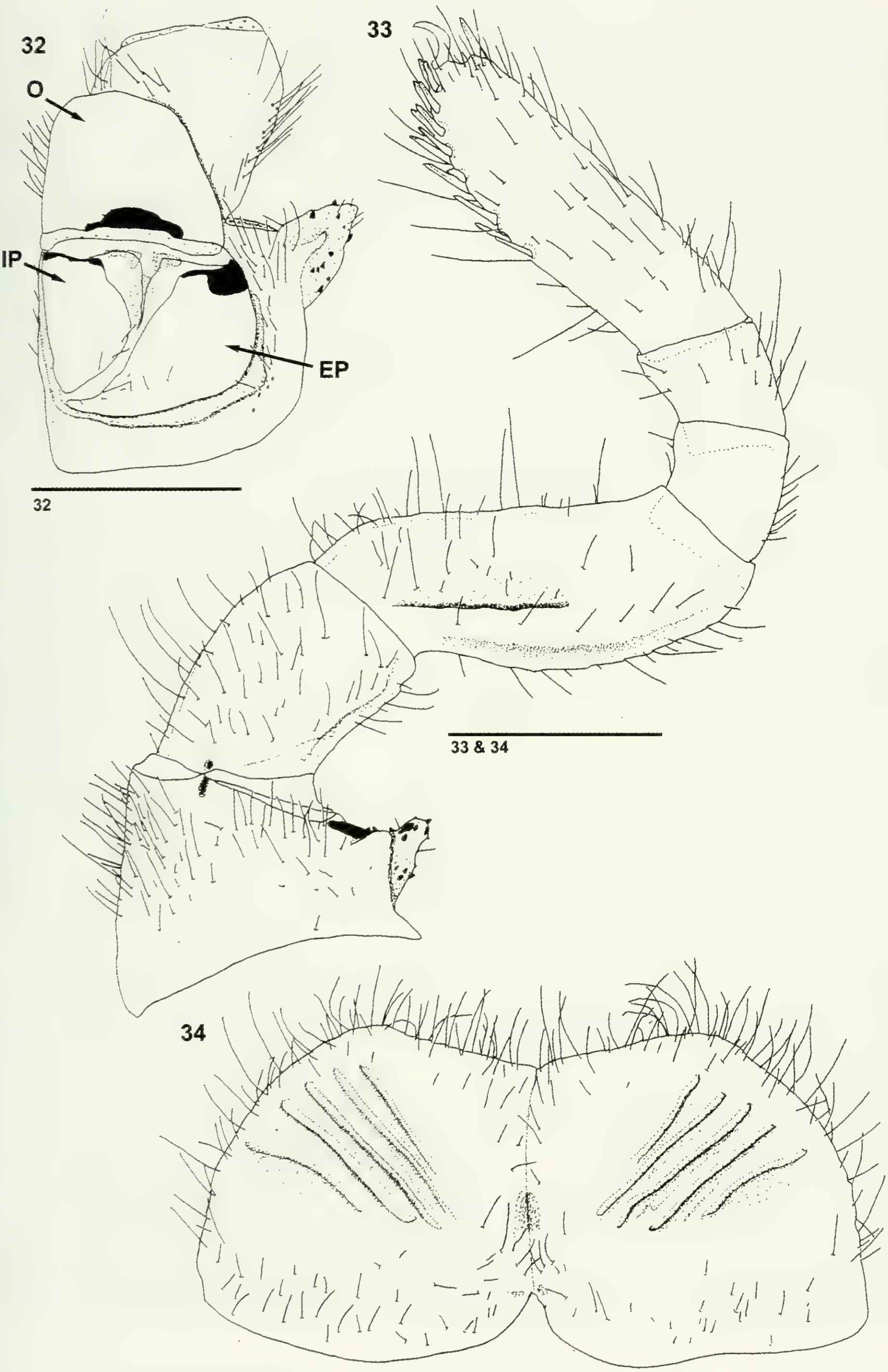
FIGURES 21–25. *Sphaeromimus musicus*, male SEM. 21: 6th joint of antennae; 22: apical part of movable finger of posterior right telopod; 23: bristle of endotergum; 24: right ocelli; 25. antennal groove with Tömösváry organ (TO) and aberrant ocellus.



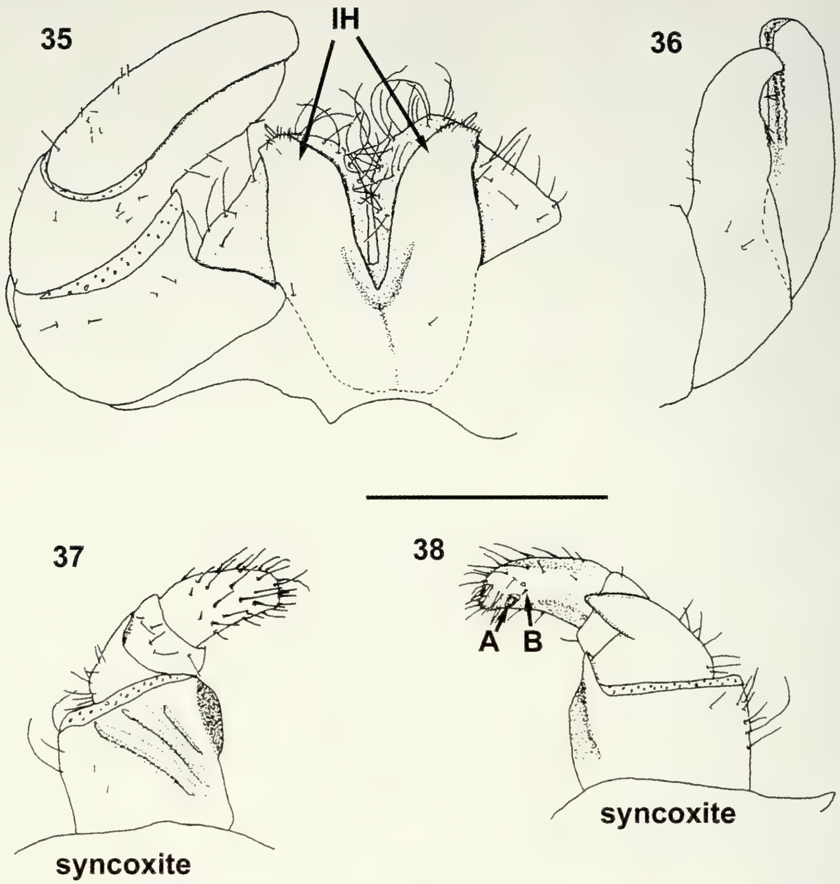
FIGURES 26–27. *Sphaeromimus musicus*, male SEM. 26: posterior side of 9th femur with toothed ridge; 27: 2nd coxa, posterior view, coxal lobe and male gonopode.



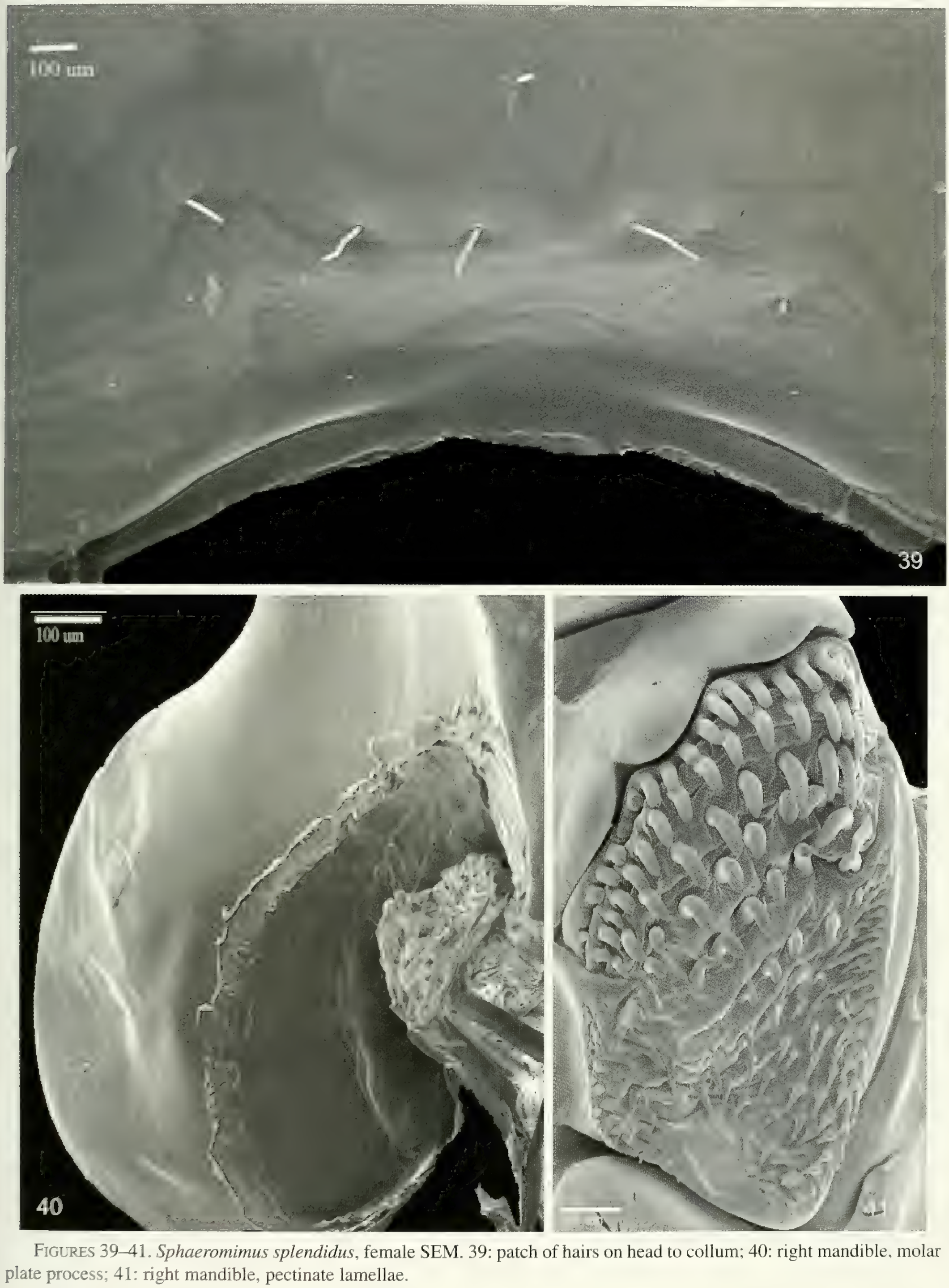
FIGURES 28–31. *Sphaeromimus splendidus*, female holotype. 28: habitus, right side; 29: habitus, left side; 30: anal shield, dorsal view of black locking carinae; 31: 1st right sternite; 12T = 12th tergite; AS = anal shield; PL = pleurite; S = sternite. Scale bars: 1 mm.



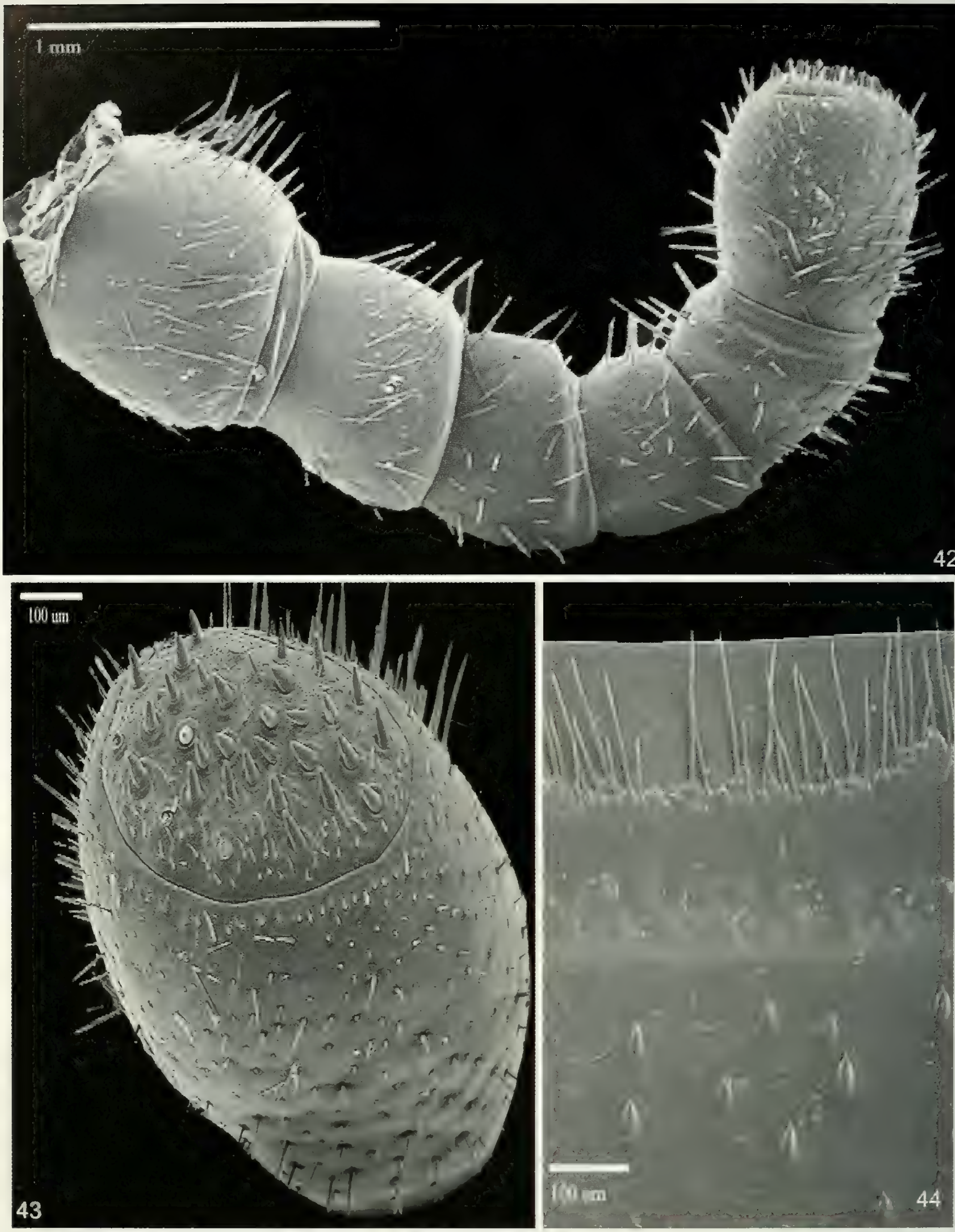
FIGURES 32–34. *Sphaeromimus splendidus*, female holotype. 32: left vulva; 33: left 9th leg, posterior view; 34: washboard; O = operculum; IP = inner plate; EP = exterior plate. Scale bar: 1 mm.



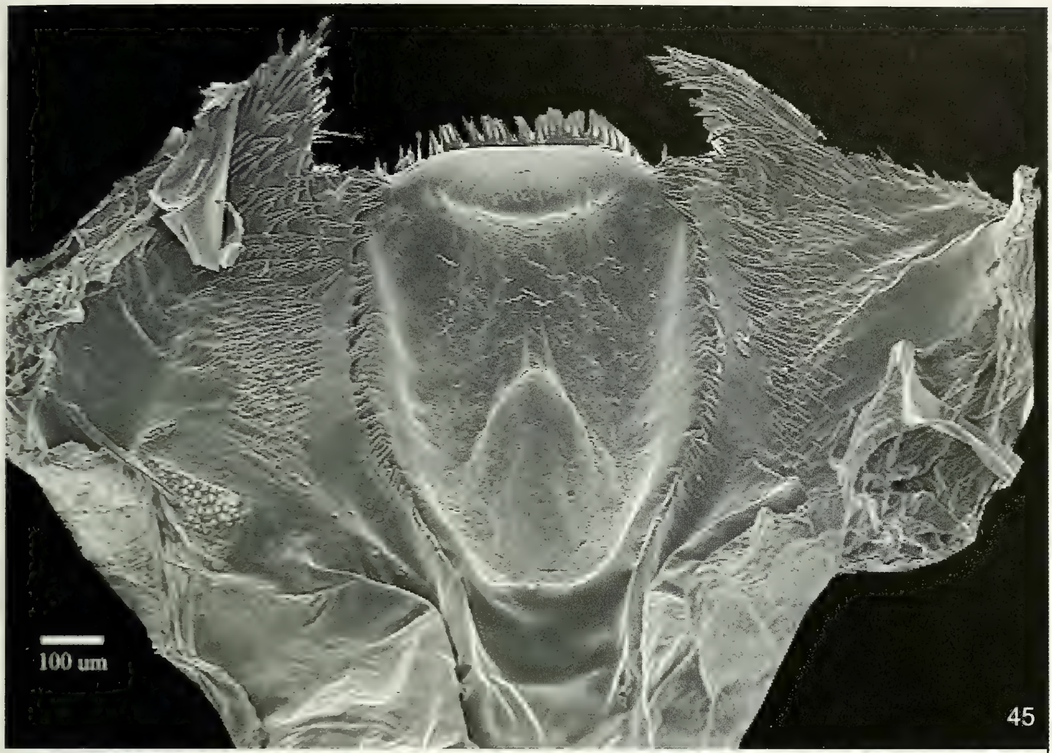
FIGURES 35–38. *Sphaeromimus splendidus*, male paratype. 35: left posterior telopod, anterior view; 36: left posterior telopod, posterior view; 37: left anterior telopod, anterior view; 38: left anterior telopod, posterior view; A = big spine; B = two small spines; IH = inner horns. Scale bar: 1 mm.

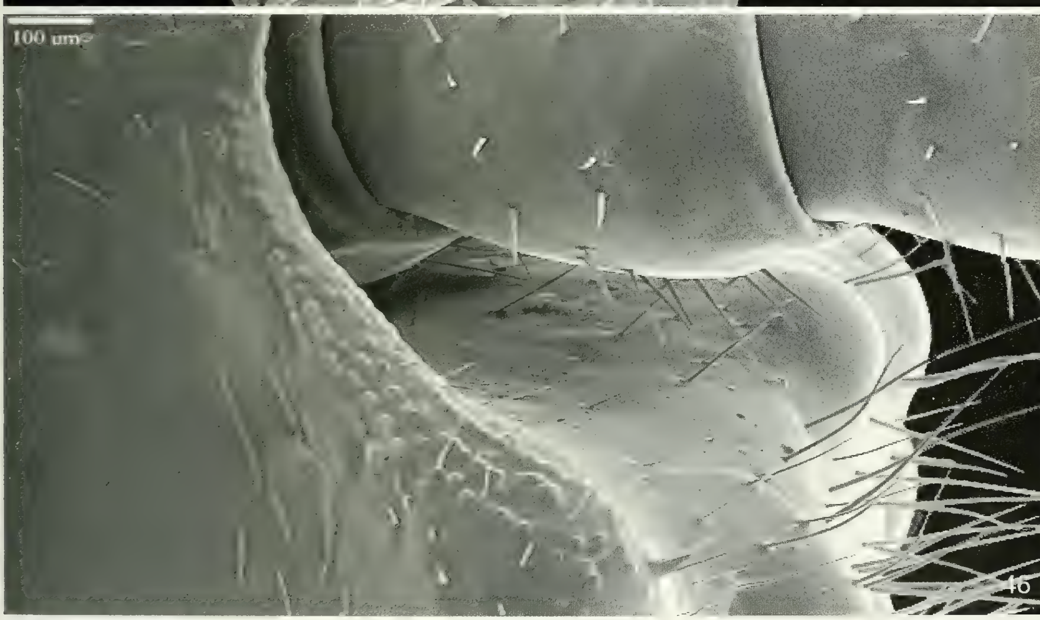


FIGURES 39–41. *Sphaeromimus splendidus*, female SEM. 39: patch of hairs on head to collum; 40: right mandible, molar plate process; 41: right mandible, pectinate lamellae.

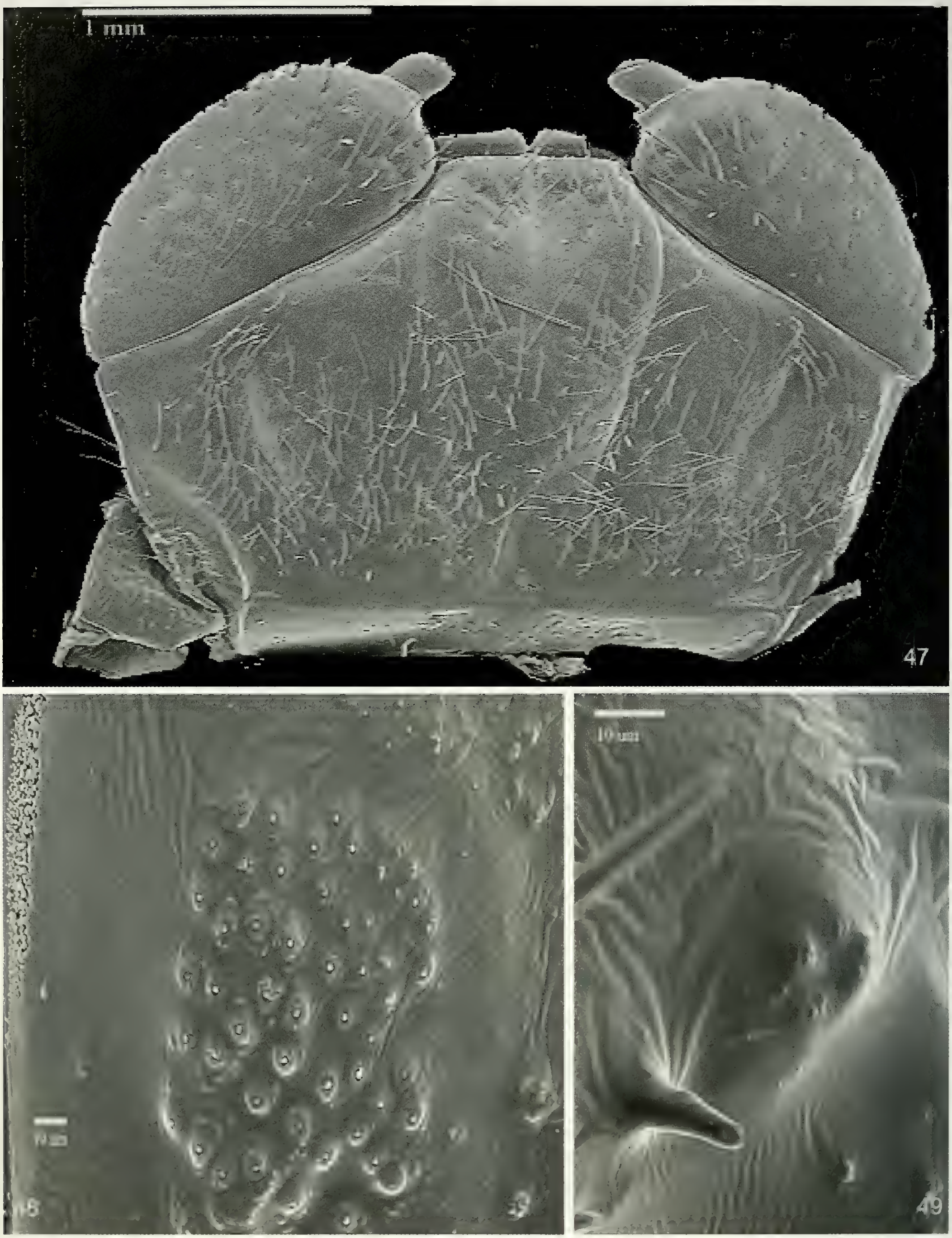


FIGURES 42–44. *Sphaeromimus splendidus*, female SEM. 42: antennae lateral; 43: 6th antennomere; 44: endotergum.





FIGURES 45–46. *Sphaeromimus splendidus*, female SEM. 45: epipharynx, anterior side; 46: edges of antennal groove with crenulated teeth and one spine.



FIGURES 47–49. *Sphaeromimus splendidus*, female SEM gnathochilarium. 47: gnathochilarium, ventral view; 48: sensual cones on medial pads; 49: pit laterally of palpi with sensual cones.

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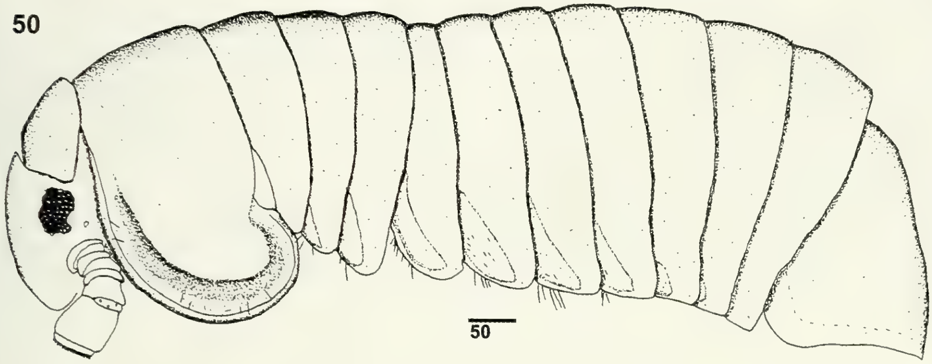

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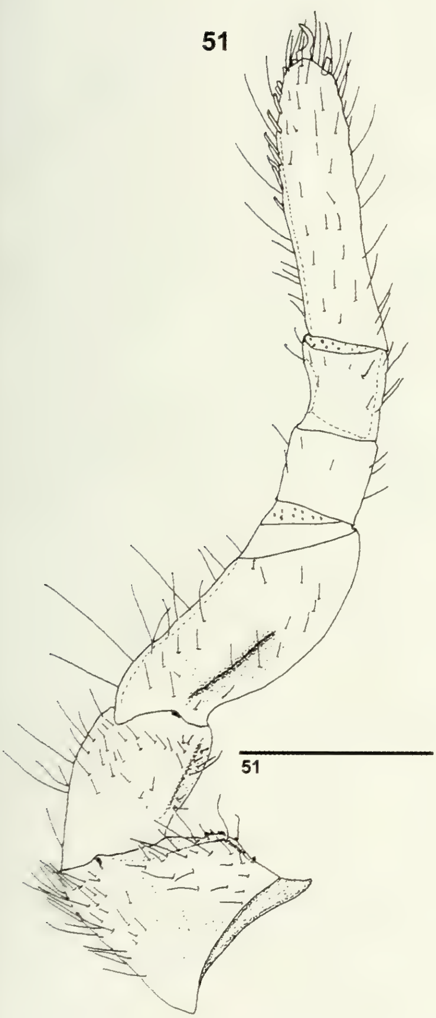

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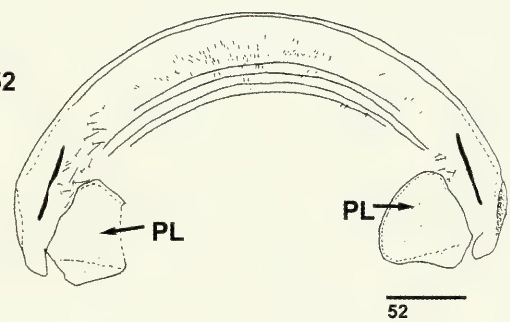

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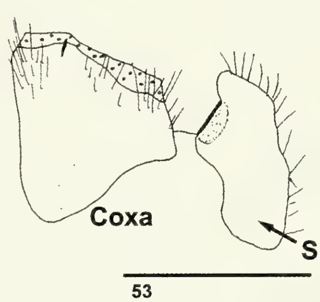
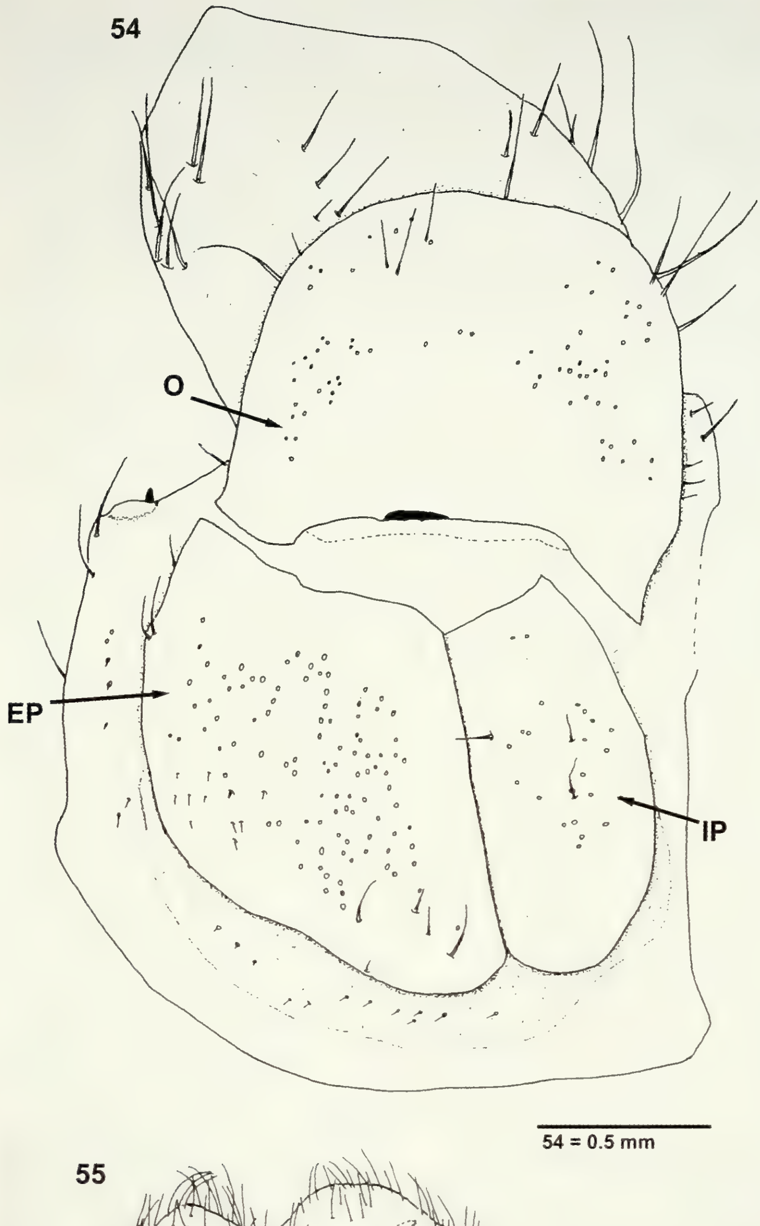


FIGURES 50–53. *Sphaeromimus inexpectatus*, male holotype. 50: habitus; 51: left 9th leg, posterior view; 52: anal shield, dorsal view of black locking carinae; 53: left 1st sternite; AS = anal shield, PL = pleurite; S = sternite. Scale bars: 1 mm.

FIGURES 54–55. *Sphaeromimus inexpectatus*, female paratype; 54: vulva (macerated); 55: washboard right; O = operculum; IP = inner plate; EP = exterior plate. Scale bars: 0.5 and 1 mm.

54



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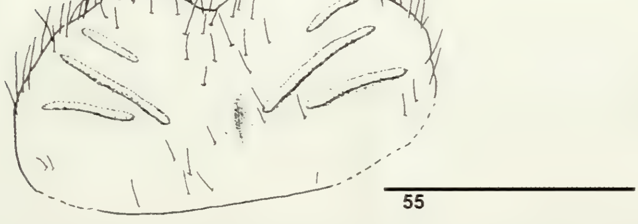
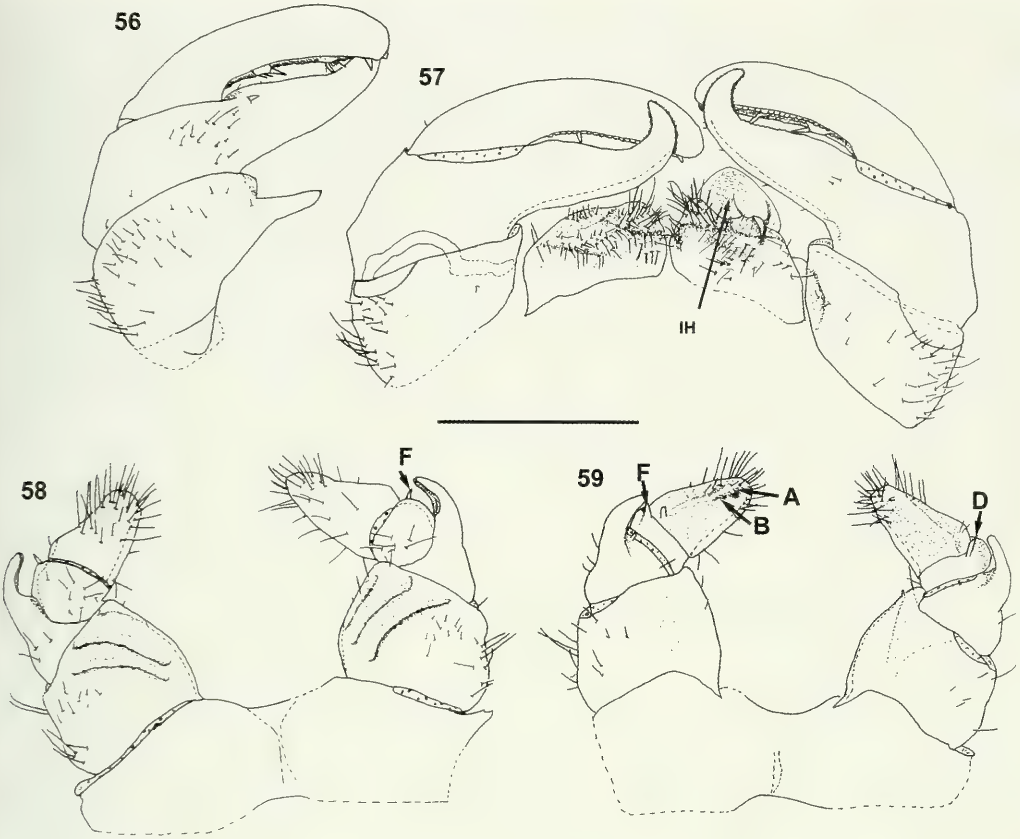
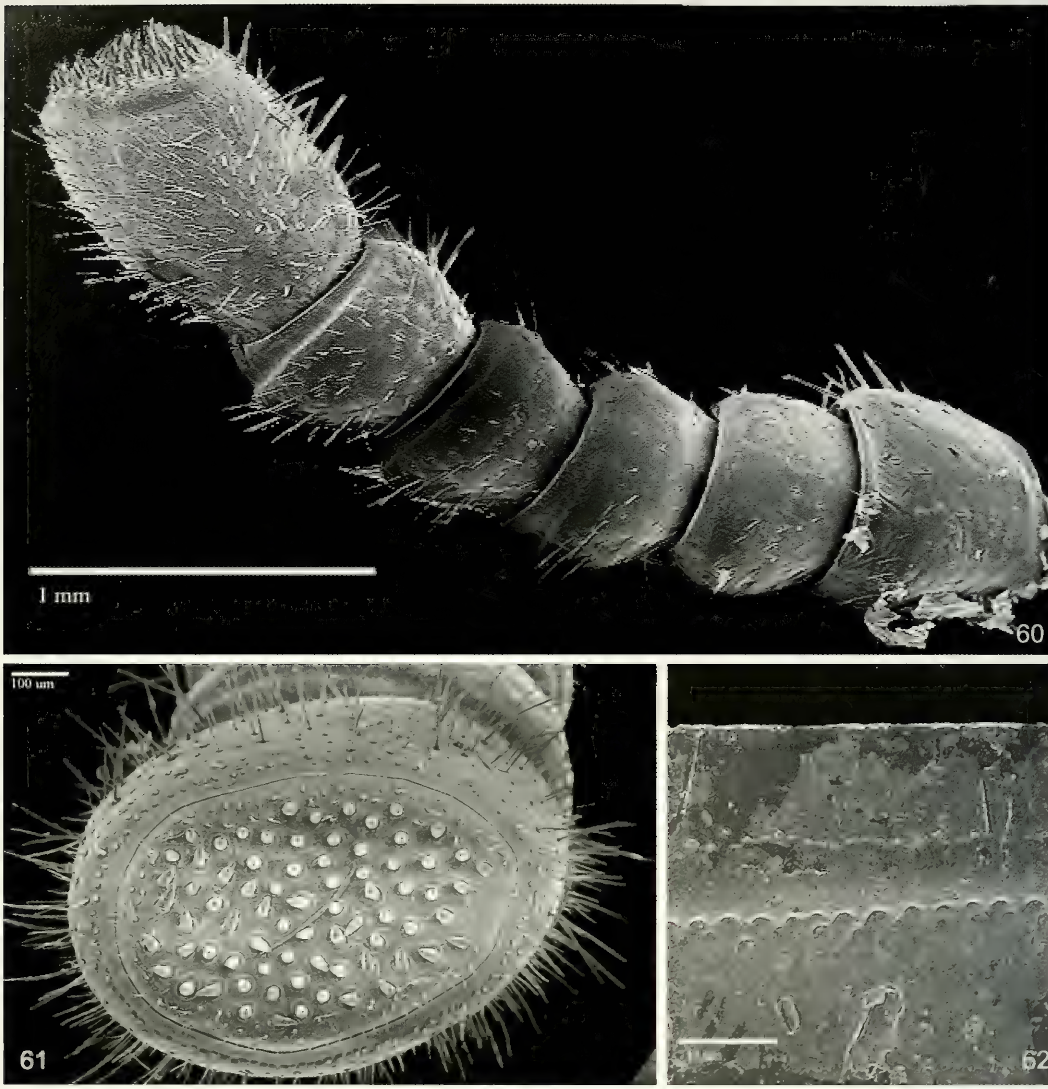




FIGURES 56–59: *Sphaeromimus inexpectatus*, male holotype; 56, left posterior telopod, posterior view; 57, posterior telopods, anterior view; 58, anterior telopods, anterior view; 59, anterior telopods, posterior view; A = big spine; B = two small spines; D = small lateral spine; F = longer spine; IH = inner horns of posterior telopod. Scale bar: 1 mm.



FIGURES 60–62. *Sphaeromimus inexpectatus*, male holotype SEM. 60: antennae lateral; 61: 6th antennomere; 62: endotergum.

FIGURE 63. *Sphaeromimus inexpectatus*, male holotype, photo.

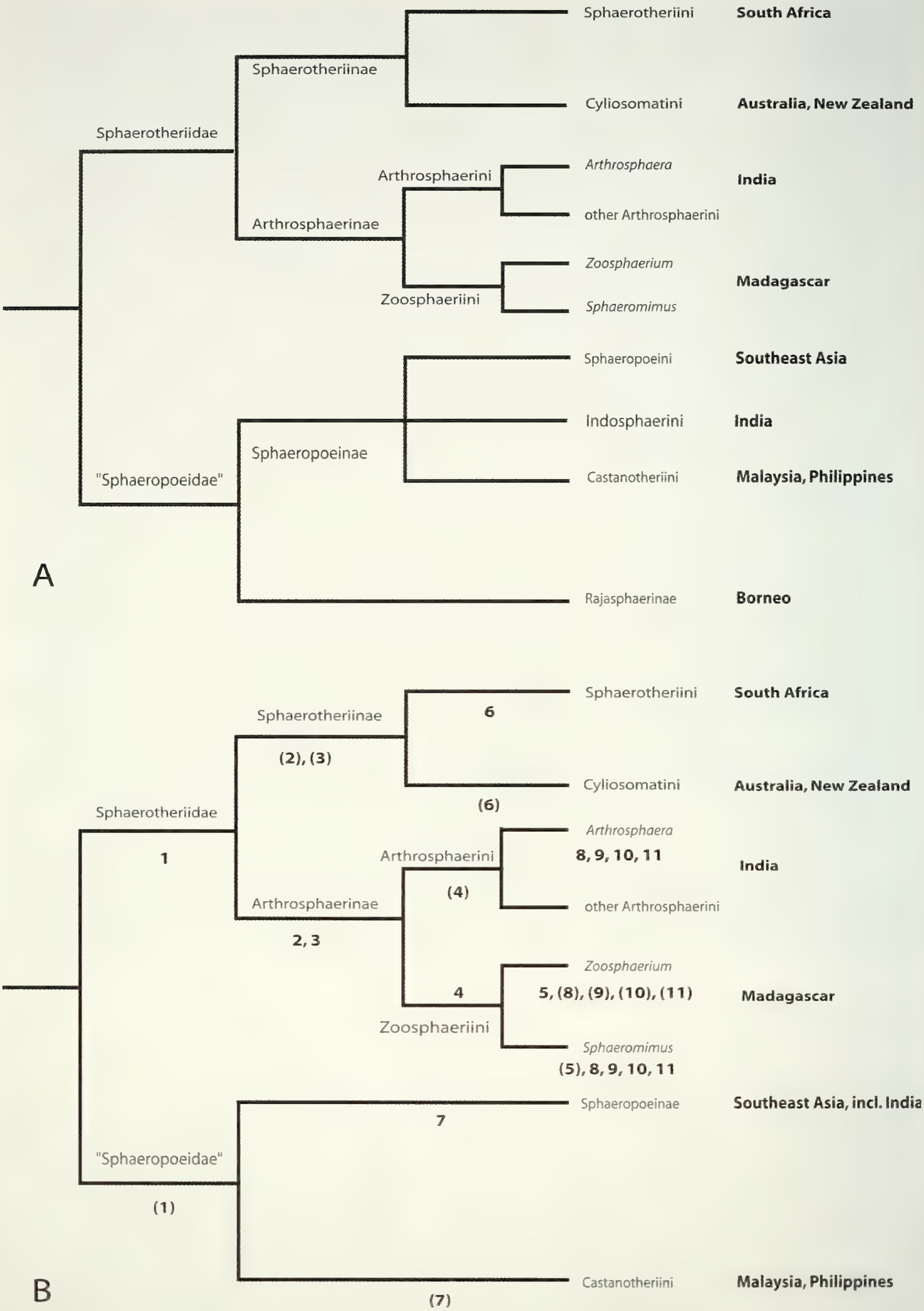

Sphaerotheriini
South Africa
Sphaerotheriinae
Cyliosomatini
Australia, New Zealand
Sphaerotheriidae
Arthrosphaerini
Arthrosphaera
India
Arthrosphaerinae
other Arthrosphaerini
Zoosphaerium
Madagascar
Zoosphaeriini
Sphaeromimus
Sphaeropoeini
Southeast Asia
Indosphaerini
India
Sphaeropoeinae
"Sphaeropoeidae"
Castanotheriini
Malaysia, Philippines
A
Rajasphaerinae
Borneo
Sphaerotheriini
South Africa
Sphaerotheriinae
6
(2), (3)
Cyliosomatini
Australia, New Zealand
(6)
Sphaerotheriidae
Arthrosphaera
1
Arthrosphaerini
8, 9, 10, 11
India
(4)
Arthrosphaerinae
other Arthrosphaerini
2, 3
Zoosphaerium
4
5, (8), (9), (10), (11)
Madagascar
Zoosphaeriini
Sphaeromimus
(5), 8, 9, 10, 11
Sphaeropoeinae
Southeast Asia, incl. India
7
"Sphaeropoeidae"
(1)
B
Castanotheriini
Malaysia, Philippines
(7)

FIGURE 65. Distribution map of *Sphaeromimus*.

FIGURE 64 (left). Classification of the order Sphaerotheriida translated into a cladogram, with geographical distributions of clades. A. After Hoffman 1976, 1980, with modifications by Mauriès 2001 incorporated. B. After Jeekel 1974. Shelley (2003) recommended use of the family name Zephronidae instead of "Sphaeropoeidae." Numbers 1-7 on branches of Fig. 64 B indicate group-defining characters used by Jeekel (1974), numbers in parentheses indicate absence of character; 1=vulval operculum embraced by bursa, 2=female washboard present, 3= medium protrusion of bursa, 4= male harp present at anterior telopod, 5= vulval operculum subreniform, 6= stridulation organ on posterior male telopods, 7= movable digit of posterior telopod consists of two distinct podomeres, (7)= movable digit of posterior telopod consists of single podomere. Numbers 8-10 indicate characters and their distributions discussed in this study: 8= 6th antennomere flat and broad, (8)=6th antennomere cylindrical, 9= four-jointed anterior telopod in males, 10= female washboard divided (known from only a single *Arthrosphaera* species), (10)= female washboard undivided (with other variable features in *Zoosphaerium*), 11= operculum well rounded, (11)= operculum with central depression.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 30, pp. 601–605, 4 figs. December 30, 2005

A Remarkable New Species of *Acropyga* (Hymenoptera: Formicidae) from Gabon, with a Key to the Afrotropical Species

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A new species of *Acropyga, A. bakwele* sp. nov., is described from Gabon. This is an intriguing species because unlike any other known because its worker possesses a median ocellus, unlike any other known *Acropyga*. This species is the largest *Acropyga* known from Africa, and one of the largest in the world. In overall appearance, the worker resembles the southern African *A. arnoldi*. A key to Afrotropical *Acropyga* is provided.

KEYWORDS: *Acropyga*, Afrotropical, Formicinae, Gabon, Hymenoptera, Lasiini, trophophoresy.

Acropyga are small formicine ants known for their habit of tending mealybugs underground on plant roots (Bünzli 1935; Weber 1944; Johnson et al. 2001; LaPolla et al. 2002). The relationship between the ants and mealybugs is complex (LaPolla et al. 2002; LaPolla 2004), and perhaps the most spectacular expression of this complexity is the fact that virgin queens emerge from their birth nests carrying a mealybug between their mandibles to presumably serve as a seed individual for the new ant colony. This behavior has been termed trophophoresy (LaPolla et al. 2002).

A recent world revision of *Acropyga* revealed 37 species (LaPolla 2004). One of the surprising results of that study was the lack of *Acropyga* species diversity from the rainforests of West and Central Africa. In other rainforest areas, such as in Southeast Asia and the Neotropics, *Acropyga* species diversity surpasses at least a dozen species in each region. LaPolla (2004) reported only two species from Africa, *A. arnoldi* and *A. silvestrii*. It remained unclear if Africa simply possessed a lower number of *Acropyga* species for unknown reasons (there are now a total of three species known from the continent), but the relatively few collections from western and central Africa may be indicative of a collecting artifact. In support of a collecting bias giving a lower number of *Acropyga* species than actually present in West and Central Africa, we report here on a new, interesting species recently collected in Gabon. Given the recent world revision by LaPolla (2004), we were able to recognize this new species and place it within a comparative framework.

Materials and Methods

In February 1998, BLF participated in a biological inventory of the Minkébé forest, an area of about 32,000 km^2, in northeastern Gabon. Goodman et al. (2001) provides additional details on the inventory. The Minkébé forest is composed of a large block of Guineo-Congo lowland forest that drains a vast area. The northern area of that forest is part of the Ntem River watershed and the rest enters into the Ivindo River. The inventory was near the northwestern boundary of the Minkébé

Protected Area in an area of pockets of mixed heterogeneous and Maranthaceae forests within a vast area of marshland. This region is part of the Aya River drainage, which forms one of the main tributaries of the Ntem River. Our camp was in place between 5 and 17 February 1998 and was located in the Province de Woleu-Ntem, 28 km ESE Minvoul 2°05.2′N, 12°22.5′E, 600 m a.s.l. We began our trek into the forest from the Baka village of Doumasi, along the Ntem and to the east of Minvoul. Three distinct habitats types were found adjacent to the camp: marshlands dominated by *Raphia*, heterogeneous forest, and homogeneous forest composed of *Gilbertiodendron*. The leaf litter transect that collected the *Acropyga* described here (BLF1684) was from forest adjacent to the marsh. The soil was moist and sandy.

All measurements were taken at 80 × power with a Leica MZ 12 microscope using an orthogonal pair of micrometers and recorded to the nearest 0.001mm and rounded to two decimal places for presentation. All measurements are given in millimeters. Digital images (Figs. 1–4) were created using a JVC KY-F75 digital camera and Syncroscopy Auto-Montage (v 5.0) software. Morphological terminology employed throughout follows Bolton (1994), with modifications where noted. Anatomical abbreviations are elaborated here:

TL: Total Length: HL+ML+GL.
HL: Head length: the length of the head proper, excluding the mandibles; measured in full-face view from the midpoint of the anterior clypeal margin to a line drawn across the posterior margin from its highest points (to accommodate species where the posterior margin is concave).
HW: Head Width: the maximum width of the head in full-face view (excluding the portion of the eyes that extend pass the lateral sides of the head).
SL: Scape Length: the maximum straight line of the antennal scape excluding the condylar bulb.
ML: Mesosoma Length: the length of the mesosoma (=alitrunk) in lateral view from the anterior most point of the pronotum (including the "neck" of the pronotum) to the posteriormost point of the metapleuron.
GL: Gaster Length: the length of the gaster in lateral view from the anteriormost point of first gastral segment (third abdominal segment) to the posteriormost point of the acidopore.
CI: Cephalic Index: HW = 100/HL.
SI: Scape Index: SL = 100/HW.

Systematic Treatment

Acropyga bakwele LaPolla and Fisher, sp. nov.

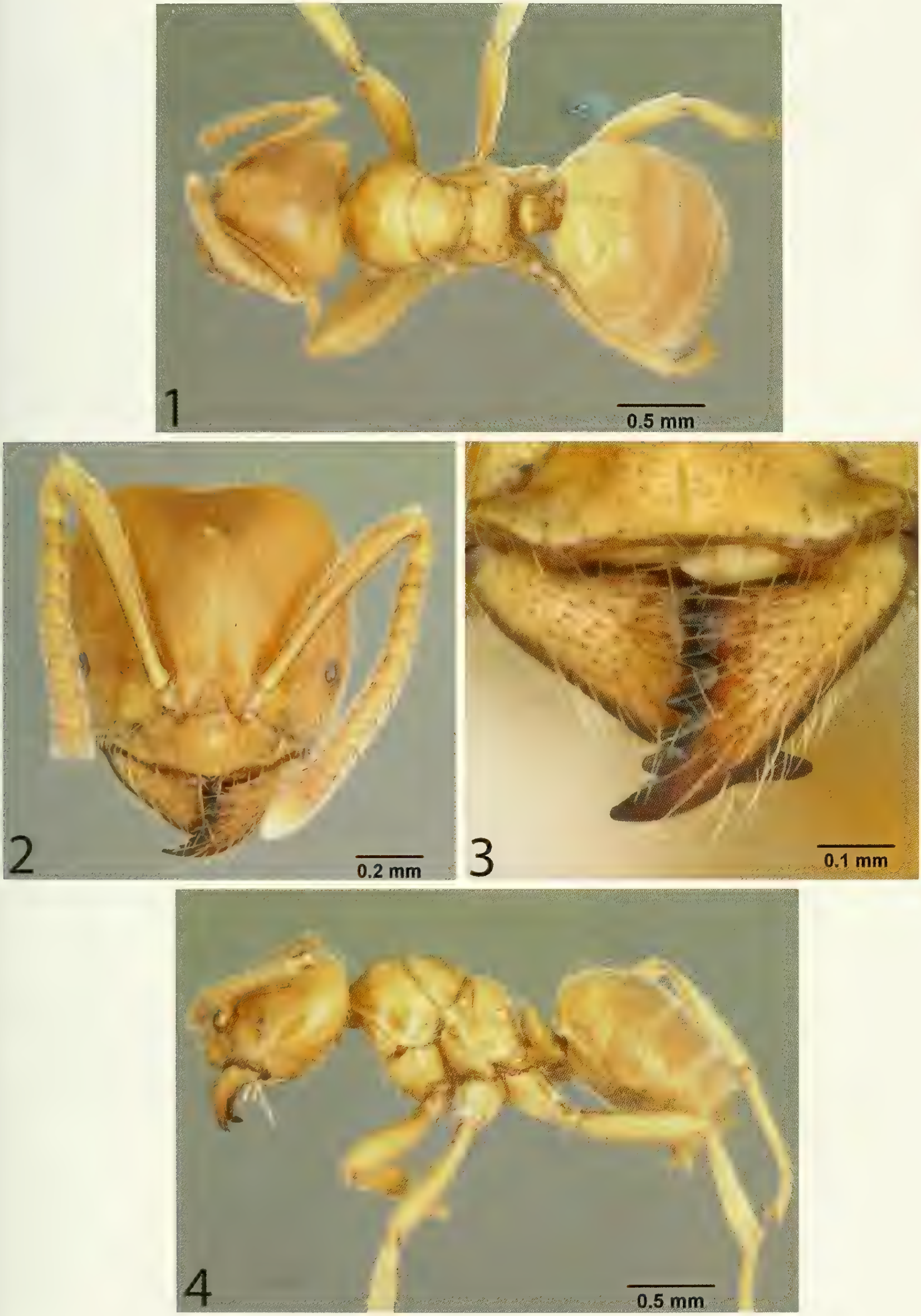
Figures 1–4.

Holotype worker.— Gabon: Province Woleu-Ntem, 31.3 km 108° ESE Minvoul, 2°04.8′N, 12°24.4′E, elev. 600 m 11.ii.1998, sifted leaf litter, rainforest (coll. B.L. Fisher) collection code: BLF01684, specimen code: CASENT0104123 (CASC)

Diagnosis.— 8-toothed mandible; mandibular apical tooth about twice as along as other teeth; median ocellus present; total length > 3 mm.

Description.— Worker: Overall appearance similar to *Acropyga arnoldi* and *A. silvestrii*, see LaPolla (2004) for details of these two species. Head (see Fig. 2): reddish-yellow; head slightly longer than wide; covered in a thick layer of appressed hairs, with short erect hairs along posterior margin; posterior margin slightly concave medially; median ocellus present; eyes relatively large for an *Acropyga* (ca. 10 facets) and placed at lower ¼ of head; 11-segmented, incrassate antennae; scape surpasses posterior margin by about half length of pedicel; scape with thick layer of appressed hairs, scattered erect hairs throughout; clypeus slightly convex medially; mandible

Figures 1–4 (right). *Acropyga bakwele*, sp. nov. 1) lateral view; 2) head in full-frontal view; 3) mandible in full frontal view; 4) dorsal view.


1
0.5 mm
2
0.2 mm
3
0.1 mm
4
0.5 mm

broad, with six distinct teeth; mandibular basal angle distinct, but not forming seventh tooth; apical tooth twice as long as other teeth (Fig. 3). Mesosoma (see Figs. 1, 4): reddish-yellow; in lateral view, pronotum with short anterior shelf; dorsum covered in layer of appressed hairs, with scattered erect to suberect hairs throughout; metanotal area distinct; propodeum rounded; declivity steep. Gaster: petiole think and erect, with erect hairs; gaster reddish-yellow, with thick layer of appressed hairs and scattered erect to suberect hairs throughout.

Queen.— Unknown.

Male.— Unknown.

Etymology.— The species epithet, *bakwele*, is in honor of the Bakwele pygmies who assisted BLF during his fieldwork in Gabon.

Measurements.— (Holotype worker) TL: 3.24; HL: 0.902; HW: 0.870; SL: 0.751; ML: 1.069; GL: 1.272; CI: 96.45; SI: 86.32.

Discussion.— This new *Acropyga* species is not only the largest species presently known from Africa, but it is also one of the largest in the world. Only four other species are known to exceed 3 mm in total length (all are Old World): *A. acutiventris*, *A. butteli*, and *A. myops* all have been observed to exceed 3 mm in total length, whereas *A. rubescens* has been observed over 5 mm in total length.

The most remarkable attribute of *A. bakwele* is the presence of a median ocellus. In the extensive review of *Acropyga* by LaPolla (2004), ocelli were never observed on workers (they are present in queens and males). Unfortunately, with only a single specimen of *A. bakwele* available for study it is impossible to know if the presence of a median ocellus is typical for this species or if the specimen is simply an aberrant worker. Nonetheless, its presence is intriguing and the collection of a nest series will hopefully clarify the point.

Nothing is known about the natural history of this *Acropyga*, except that was collected from sifted leaf litter (a method that commonly collects *Acropyga*) in moist, sandy soil rainforest, near an extensive network of marshland. Where the natural history is known, *Acropyga* are found to nest close to soil in leaf litter, rotting logs, and under stones. They form large colonies with thousands of workers, and some species are possibly polygynous.

The relationship of *A. bakwele* to other species is uncertain, but superficially all African species and *A. paleartica* (known only from Greece) appear closely related. Pending the discovery of *A. bakwele* males, the species remains unplaced in a species-group. The holotype worker resembles *A. arnoldi* in many respects. However, *A. bakwele* is significantly larger than *A. arnoldi*, possesses a longer mandibular apical tooth, and has erect hairs scattered throughout the mesosomal dorsum. One interesting characteristic of *A. bakwele* is that, like *A. arnoldi* and *A. paleartica*, it possesses a 5:4 palpal formula, a characteristic that may be associated with more basal *Acropyga*. In fact, LaPolla (2004) hypothesized that *A. arnoldi* represented that most basal extant species. All African *Acropyga* have worker morphologies that suggest a more basal placement. The mandible in all species can possess over six teeth, with *A. arnoldi* known to possess up to nine teeth. *A. silvestrii* is known to possess up to seven teeth, although some specimens have been recorded with as few as four.

Key to Afrotropical *Acropyga* species (workers)

The following key is modified from LaPolla (2004)

1. Head width < 0.55 mm . . . . *A. silvestrii*
   Head width > 0.55 mm 2
2. Head width < 0.7 mm; total length < 3 mm; erect hairs concentrated on the posterior pronotum; median ocellus absent; southern Africa. . . . . *A. arnoldi*
   Head width > 0.7 mm; total length > 3 mm; erect hairs scattered throughout dorsum; median ocellus present; West Africa. . . . . *A. bakwele*, sp. nov.

Acknowledgments

Funding for the BLF's field research was provided by WWF-US. Travel for JSL to California was provided by the Smithsonian Institution's Office of Sponsored Research and National Science Foundation under Grant No. INT 9998672 to BLF. We thank April Nobile for creating the images. We thank Wojciech Pulowski and Donat Agosti for their reviews of the paper.

References

Bolton, B. 1994. Identification guide to the ant genera of the world. Harvard University Press, Cambridge, Massachusetts, USA. 222 pp.

Bünzli, G.H. 1935. Untersuchungen über coccidophile Ameisen aus den Kaffeefelden von Surinam. *Mitteilungen der Schweizerischen Entomologischen Gesellshaft* 16:455–593.

Goodman, S.M, R. Hutterer, and P. R. Ngnegueu. 2001. A report on the community of shrews (Mammalia: Soricidae) occurring in the Minkébé Forest, northeastern Gabon. *Mammalian Biology* 66:22–34.

Johnson, C., D. Agosti, J. H. C. Delabie, K. Dumpert, D. J. Williams, M. von Tschirnhaus, and U. Maschwitz. 2001. *Acropyga* and *Azteca* ants (Hymenoptera: Formicidae) with scale insects (Sternorhyncha: Coccoidea): 20 million years of intimate symbiosis. *American Museum Novitates* 3335:1–18

LaPolla, J.S. 2004. *Acropyga* (Hymenoptera: Formicidae) of the World. *Contributions of the American Entomological Institute* 33(3):1–130.

LaPolla, J.S., S.P. Cover, and U.G. Mueller. 2002. Natural history of the mealybug-tending ant *Acropyga epedana*, with descriptions of the male and queen castes. *Transactions of the American Entomological Society* 128(3):367–376.

Weber, N.A. 1944. The Neotropical coccid-tending ants of the genus *Acropyga* Roger. *Annals of the American Entomological Society* 37:89–122.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 31, pp. 607–617, 5 figs. December 30, 2005

New and Reconsidered Mexican Acanthaceae XI: *Justicia* in the Yucatan Peninsula

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Two new species (*Justicia edgarcabrerae* and *J. luzmariae*) and a new combination (*J. leucothamna* based on *Jacobinia leucothamna* Standl.) are proposed for the acanthaceous flora of the Yucatan Peninsula. Distribution maps, images of pollen, and illustrations/photos are presented for all three species. Studies of Acanthaceae in the three states (Campeche, Quintana Roo, and Yucatán) composing the Mexican portion of the Yucatan Peninsula reveal the presence of at least 38 native species of Acanthaceae there. Five of the 13 species of Justicia there are endemic to these states.

RESUMEN

Dos especies nuevas (*Justicia edgarcabrerae* y *J. luzmariae*) y una combinación nueva (*J. leucothamna* basado en *Jacobinia leucothamna* Standl.) se proponen para la flora de acantáceas de la Península de Yucatán. Se presentan mapas de las distribuciones, imágenes de polen, e ilustraciones/fotos para cada especie. Estudios de las Acanthaceae en los tres estados (Campeche, Quintana Roo y Yucatán) que comprenden la porción mexicana de la Península de Yucatán revelan la presencia por lo menos de 38 especies nativas de Acanthaceae allí. Cinco de las 13 especies de Justicia que crecen allí son endémicos a estos estados.

Leonard (1936) treated 59 native species in the plant family Acanthaceae from the Yucatan Peninsula of southern Mexico and northern Central America. Twenty-seven of these were reported from the three states (Campeche, Quintana Roo, and Yucatán) that compose the Mexican portion of the peninsula. Recent studies (Daniel, unpublished and this study) reveal the presence of 38 native species of Acanthaceae in these three Mexican states. Nine of them (24 percent) are endemic there. Although the acanthaceous flora of the Mexican portion of the Yucatan Peninsula is not especially rich in species, the level of endemism there at that taxonomic rank is significantly greater than that noted for several other regions of Mexico, including: Chiapas with 13 percent (Daniel 2005a), "El Bajío" with 5 percent (Daniel and Acosta 2003), Sonora with 3 percent (Daniel 2004), and the Tehuacán-Cuicatlán Valley with 14 percent (Daniel 1999). However, it is nearly equal to the 26 percent endemism reported by Daniel (1997) for species of Acanthaceae in the peninsula of Baja California, another very dry region that is not rich in species. The level of endemism for the Acanthaceae in the Mexican portion of the Yucatan Peninsula is also high compared to the estimated 8.2 percent endemism for the total vascular flora of this region (Carnevali et al. 2003).

Justicia is the largest genus of Acanthaceae with more than 700 species recognized worldwide. It is also the largest genus of Acanthaceae in the Mexican portion of the Yucatan Peninsula with at least 13 species native there. Two of these species from the Yucatan Peninsula are newly described below and a combination is made in *Justicia* for the species previously known as *Jacobinia leucothamna* Standl. Five species of *Justicia* (*J. cobensis* Lundell, *J. dendropila* T.F. Daniel, *J. edgarcabrerae*, *J. leucothamna*, and *J. lundellii* Leonard) are endemic to one or more of the three states composing the Mexican portion of the Yucatan Peninsula. Another one, *J. luzmariae*, is known only from this region and adjacent northern Belize.

Ongoing studies toward a comprehensive taxonomic account of the Acanthaceae of the Mexican portion of the Yucatan Peninsula (Daniel, in progress), including field and herbarium research since 2002, have identified undescribed species (Daniel 2003) and new distribution records (Carnevali et al. 2005; Daniel 2005b) for the family. Additional discoveries and a taxonomic renovation are provided herein.

Justicia luzmariae **T.F. Daniel, Carnevali, and Tapia, sp. nov.**
Fig. 1.

TYPE.— MEXICO: **Quintana Roo**: Mpio. Lázaro Cárdenas, along hwy. between Kantunilkín and Chiquilá, 7 km S of Chiquilá, 21°22.7′N, 87°22.3′W, 10 m, disturbed evergreen seasonal forest, 25 February 2003, *T. Daniel, G. Carnevali, & J.L. Tapia Muñoz 10315* (holotype: MEXU!; isotypes: BR!, CAS!, CICY!, CIQR!, ENCB!, F!, GH!, K!, MICH!, MO!, NY!, TEX!, UCAM!, US!).

Frutices usque ad 5 m longi vel alti. Folia petiolata, laminae (ovato-ellipticae vel) ellipticae vel subcirculares, 21–90 mm longae, 12–63 mm latae, 1.0–2.6-plo longiores quam latiores. Inflorescentia floribus in spicis vel paniculis spicarum. Bracteae obovatae vel obovato-ellipticae, 3–9 (–14) mm longae, 1–5 (–7) mm latae. Calyx 5-lobus, 6–11 mm longus, lobis homomorphis. Corolla viridi-alba vel viridi-lutea et intus maculata, 12–23 mm longa, extus pubescens trichomatibus eglandulosis. Stamina thecis 1.4–2 mm longis, impariter insertis, pubescentibus, basi calcaratis; pollinis granae 3-aperturatae. Capsula 8.5–14 mm longa, glabra.

Clambering (sometimes appearing vinelike) shrubs to 5 m long or tall. Young stems subquadrate to quadrate, bifariously pubescent with retrorse eglandular trichomes 0.1–0.4 mm long. Leaves petiolate, petioles to 25 mm long, blades subcoriaceous, somewhat discolorous (lighter green abaxially than adaxially), (ovate-elliptic to) elliptic to broadly elliptic to subcircular, 21–90 mm long, 12–63 mm wide, 1.0–2.6 times longer than wide, rounded to acute to subcordate and often asymmetric at base, rounded to acute at apex, surfaces and margin glabrous (or with a few eglandular trichomes along midvein on adaxial surface), margin entire, sometimes ± revolute. Inflorescence of axillary and/or terminal sessile or pedunculate dichasiate spikes or panicles of dichasiate spikes to 132 mm long (including peduncle, if present), axillary spikes (or panicles of spikes) (alternate to) opposite, 1 per axil, fertile portion of spikes 7–14 mm in diameter near midpoint (excluding flowers), peduncles of spikes to 47 mm long, pubescent like young stems, rachis bifariously pubescent with flexuose to retrorse to antrorse eglandular trichomes 0.2–0.5 mm long, inflorescence bracts (i.e., when panicles of spikes present) subulate to elliptic, 2–5 mm long, 1–2 mm wide; dichasia opposite, 1 per axil, 1-flowered, sessile. Bracts obdeltate to obovate to obovate-elliptic, 3–9 (–14) mm long, 1–5 (–7) mm wide, apically (rounded to) truncate to emarginate, abaxial surface sparsely pubescent with antrorse to antrorsely appressed eglandular trichomes 0.1–0.3 mm long (trichomes mostly or entirely restricted to midvein), margin ciliate with flexuose to antrorse eglandular trichomes. Bracteoles linear to linear-elliptic to lunate to lanceolate (sometimes

FIGURE 1. *Justicia luzmariae*. a. Habit (*Crane 509*), ×0.5. b. Inflorescence (*Gómez-Pompa 1352*), ×3. c. Distal portion of stamen with anther (*Gómez-Pompa 1352*), ×13. d. Distal portion of style with stigma (*Gómez-Pompa 1352*), ×23. e. Capsule (*Crane 509*), ×5, opening capsule (top) and inner side of a single valve (bottom). Drawn by Meg Stalcup.

asymmetric), 2.5–7 mm long, 1–2 mm wide, abaxial surface pubescent like bracts. Flowers sessile. Calyx 5-lobed, 6–11 mm long, lobes homomorphic, lanceolate, 5–10 mm long, 1–2 mm wide, abaxially glabrous or with a few trichomes like those on bracts. Corolla greenish externally, greenish white to greenish yellow internally and with maroon markings on both lips (or with the lower lip sometimes light to dark maroon with yellowish green markings), 12–23 mm long, externally pubescent with erect to flexuose eglandular trichomes 0.2–0.5 mm long, tube ± abruptly expanded

in proximal ⅓ to ± gradually expanded distally, 5.5–10 mm long, 3.5–5 mm in diameter near midpoint, internally densely pubescent near base of stamens, upper lip 6–12 mm long, 2-lobed at apex, lobes to 0.5 mm long, lower lip 6–14 mm long, lobes rounded, 1–3 mm long, 1.3–2 mm wide. Stamens inserted between base and midpoint of corolla tube, 8–17 mm long, filaments glabrous, thecae greenish turning maroon, parallel to subparallel, 1.4–2 mm long (including basal appendage), equal to subequal, unequally inserted (overlapping by 0.5–1.2 mm), both dorsally pubescent with flexuose eglandular trichomes, both with blunt basal appendages 0.3–0.7 mm long (appendage of lower theca larger than that of upper theca); pollen (Fig. 2) 3-aperturate, apertures flanked on each side by 1 row of insulae, exine reticulate. Style 7–19 mm long, proximally pubescent with eglandular trichomes, becoming glabrous distally, stigma 0.1–0.2 mm long, asymmetric, lobes sometimes inconspicuous. Capsule 8.5–14 mm long, glabrous, stipe 2.5–4 mm long, head ellipsoid to obovoid, 6–10 mm long. Seeds 4, plano-convex, 3.2–3.5 mm long, 2.2–2.3 mm wide, surfaces smooth (micropapillate), lacking trichomes.

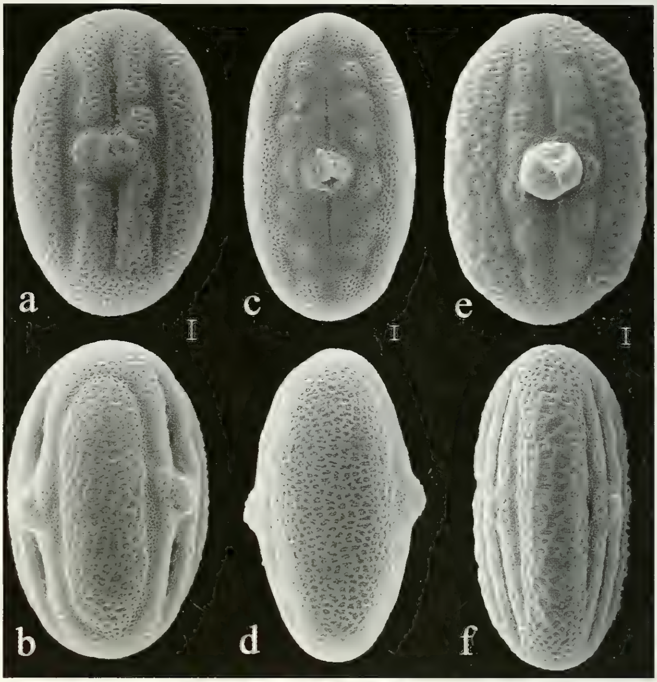

FIGURE 2. Scanning electron micrographs of pollen. a,b. *Justicia edgarcabrerae* (*Cabrera & Durán 624*), apertural view (a) and interapertural view (b). c,d. *Justicia leucothamna* (*Leal & Rico-Gray 111*), apertural view (c) and interapertural view (d). e. *Justicia luzmariae* (*Cabrera et al. 16373*), apertural view. f. *Justicia luzmariae* (*Gómez-Pompa 1352*), interapertural view. All scales = 2 µm.

PHENOLOGY.— Flowering: January–March; fruiting: February–April.

DISTRIBUTION AND HABITAT.— Yucatan Peninsula of Mexico (Campeche, Quintana Roo) and northern Belize (Corozal); plants occur in evergreen seasonal forests ("selva mediana subperennifolia") and tropical subdeciduous forests ("selva baja subcaducifolia") at elevations of 10–301 m.

PARATYPES.— MEXICO: **Campeche**: Mpio. Calakmul, 3 km E del poblado La Lucha, 18°26′N, 89°25′W, *D. Alvarez & C. Jiménez J. 4205* (CAS); Mpio. Calakmul, 3 km E del poblado Chichonal, carretera Xpujil–Escárcega, 18°31′N, 89°32′W, *D. Alvarez & C. Jiménez J. 4238* (CAS); Mpio. Calakmul, 4.2 km N del poblado La Nueva Vida, 18°50′N, 89°22′W, *D. Alvarez & C. Jiménez J. 4369* (CAS); Mpio. Calakmul, Puente Papagayo, 25 km N de Xpujil, 18°44′N, 89°24′W, *J. Calónico S. et al. 21795* (CAS); Mpio. Hopelchén, S de Xpujil rumbo a la frontera, 18°09.5′N, 89°27.5′W, *C. Chan 4572* (CICY, GH, MO, UCAM); 30 km de Sohlaguna, *A. Gómez-Pompa 1352* (CAS, CICY). **Quintana Roo**: Mpio. Carrillo Puerto, 6–10 km NE de Felipe Carrillo Puerto, camino a Vigía Chico, *E. Cabrera et al. 16373* (CAS); 7–8 km S de Chiquilá, a lo largo de la carretera Chiquilá-Kantunilkín, ca. 21°22′42″N, 87°22′18″W, *G. Carnevali et al. 6733* (CAS, CICY, HUH, MEXU, MO, NY, UCAM, UJAT, US, XAL); Mpio. Felipe Carrillo Puerto, ca. 6 km NE of Felipe Carrillo Puerto on road to Vigía Chico, 19°35.9′N, 88°00.3′W, *T. Daniel 10298* (BR, CAS, CICY, CIQR, K, MEXU, MO, NY, US); Mpio. Lázaro Cárdenas, 6 km ENE of San Angel along road (departs Kantunilkín–Chiquilá hwy. 30 km S of Chiquilá) to E. Zapata, 21°14.2′N, 87°23.2′W, *T. Daniel et al. 10316*

(BR, CAS, CICY, K, MEXU). BELIZE: **Corozal**: Cerros Maya Ruins, Lowrey's Bight, *C. Crane 509* (BRIT, LL).

Vegetatively, *Justicia luzmariae* appears superficially similar to (and has occasionally been identified as) *Bravaisia berlandieriana* (Nees) T.F. Daniel. Putative relatives of this species are not obvious among known species of *Justicia* from Mexico and Central America, nor does it conform to any of the sections of the genus recognized by Graham (1988). Among other species of *Justicia* occurring in the Yucatan Peninsula, *J. luzmariae* resembles *J. lundellii* in the shared characters of densely bracteate spike-like inflorescences with prominent bracts, equally 5-lobed calyces, dorsally pubescent thecae, and 3-aperturate pollen. In the latter species, however, the calyx is 2.5–3 mm long, the corolla is 7–9 mm long, the pollen is pseudocolpate (lacking insulae), the capsule is pubescent, and the seeds are bacculate.

The species appears to be widespread in eastern and southern regions of Yucatan Peninsula (Fig. 3); it has yet to be collected in the state of Yucatán. Within *J. luzmariae*, plants from northern Quintana Roo (*Carnevali et al. 6733*, *Daniel et al. 10315*, and *Daniel et al. 10316*; Fig. 4) differ from those from central Quintana Roo, southern Campeche, and Belize (all other collections cited; Fig. 1) by their longer corollas (17–23 mm vs. 12–14 mm), stamens (14–17 mm vs. 8–9 mm), and styles (17–19 mm vs. 7–12 mm). Variation in coloration of corollas is also evident in the two populations from northern Quintana Roo. There, the internal surface of the lower lip varies from greenish yellow with maroon markings to light or dark maroon with greenish yellow markings (Fig. 4). The difference in floral length suggests that plants have different pollinators in the two regions. In all other features, plants from northern Quintana Roo appear identical to those from southern Quintana Roo and Campeche.

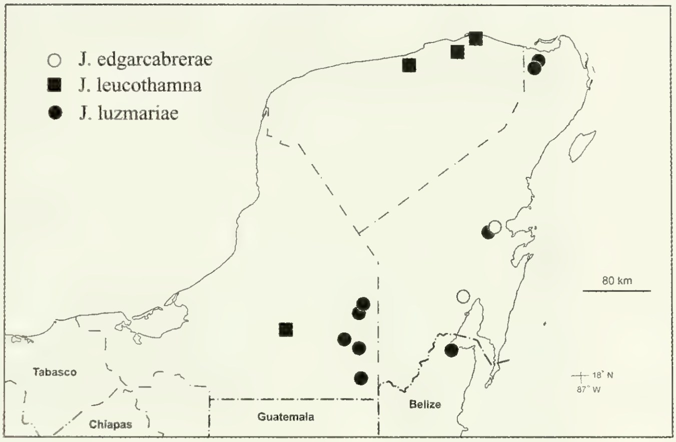

FIGURE 3. Map of the Mexican portion of the Yucatan Peninsula (with states, clockwise from left: Campeche, Yucatán, and Quintana Roo), showing distributions of *Justicia edgarcabrerae*, *J. leucothamna*, and *J. luzmariae*.

The epithet of this species honors Dra. Luz María Calvo Irabién, community ecologist at the Centro de Investigación Científica de Yucatán, whose studies and photographs of plants from near Kantunilkín led us to this species.

Justicia edgarcabrerae T.F. Daniel, Carnevali, and Tapia, sp. nov.
Fig. 5

TYPE.— MEXICO: **Quintana Roo**: brecha a Santa Cruz, 1 km S de Pedro A. Santos, 9 Dec 1980, *E. Cabrera & G. Durán 624* (holotype: CAS!; isotype: MEXU!).

Herbae perennes usque ad 1 m altae. Folia petiolata, laminae ovatae, 13–44 mm longae, 6.5–21 mm latae, 1.5–2.3-plo longiores quam latiores. Spicae axillares. Bracteae spathulatae vel late ellipticae vel subcirculares vel subdeltatae, (5–) 6–9 mm longae, (1–) 2–6.5 mm latae. Calyx 5-lobus, 3.5–5 mm longus, lobis homomorphis. Corolla luteola, 8.3–11.3 mm longa, extus pubes-

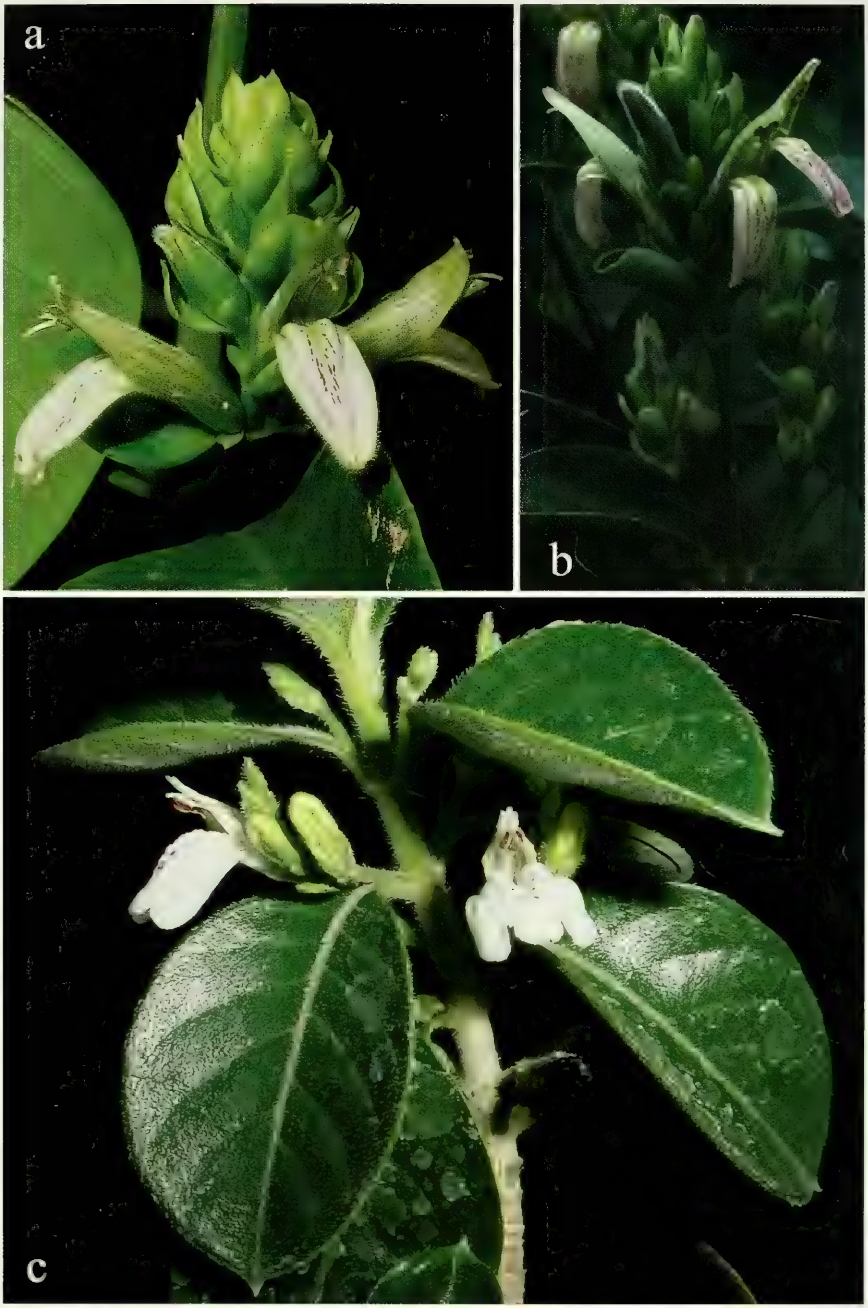

FIGURE 4. Photographs of *Justicia luzmariae* (a, b) and *J. leucothamna* (c). a. *Carnevali et al. 6733*, ×1.8. b. *Daniel et al. 10316* (maroon form), ×1.3. c. *Tapia & Cházaro 1453*, ×2.5.

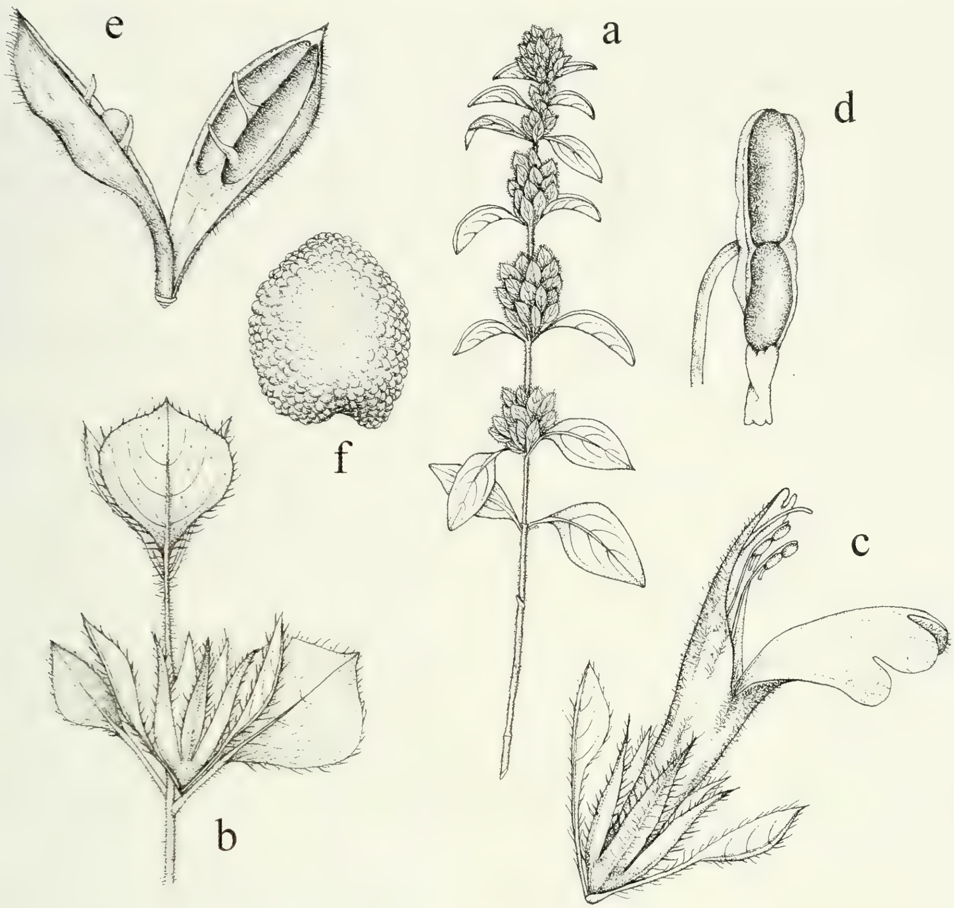

FIGURE 5. *Justicia edgarcabrerae*. a. Habit (*Cabrera & Durán 624*), ×0.4. b. Inflorescence nodes (*Cabrera & Durán 624*), ×4.8. c. Dichasium (*Cabrera 16968* and *Cabrera & Durán 624*), ×5.8. d. Distal portion of stamen with anther (*Cabrera & Durán 624*), ×17.3. e. Capsule (*Cabrera & Durán 624*), ×7.2. f. Seed (*Salazar C. 26*), ×22.6. Drawn by Nadia Strasser.

cens trichomatibus glandulosis et eglandulosis. Stamina thecis 1.1–1.4 mm longis, impariter insertis, theca supera pubescens trichomatibus eglandulosis, theca inferna basi calcarata; pollinis granae 3-aperturatae. Capsula 5.5–6.5 mm longa, pubescens trichomatibus eglandulosis.

Perennial herbs to 1 m tall. Young stems subquadrate, pubescent with erect to flexuose eglandular trichomes 0.5–1.2 mm long, trichomes disposed throughout but ± concentrated in 2 lines. Leaves petiolate, petioles to 8 mm long, blades ovate, 13–44 mm long, 6.5–21 mm wide, 1.5–2.3 times longer than wide, (rounded to) acute at apex, acute to subattenuate at base, surfaces pubescent with erect to flexuose to antrorse eglandular trichomes, margin entire. Inflorescence of axillary (and terminal) pedunculate dichasiate spikes to 53 mm long (including peduncles and excluding flowers), 10–11 mm in diameter near midspike, spikes opposite at nodes, 1–2 per axil, borne on peduncles to 5 mm long, rachis ± evenly pubescent with erect to flexuose to antrorse eglandular trichomes 0.3–0.8 mm long; dichasia alternate, sessile, 1-flowered. Bracts opposite to subopposite, spatulate to broadly-elliptic or subcircular or subdeltate and stalked at base, (5–) 6–9 mm long, (1–) 2–6.5 mm wide, fertile bracts somewhat larger than to conspicuously larger than sterile bracts

(i.e., bracts subheteromorphic to heteromorphic), rounded to acute at apex, abaxial surface pubescent with erect to flexuose eglandular and glandular trichomes 0.2–0.5 mm long, margin ciliate with trichomes like those of abaxial surface and with eglandular trichomes to 1.3 mm long as well. Bracteoles oblanceolate (often asymmetric) to linear, 4–7 mm long, 0.2–1.4 mm wide, pubescent like bracts. Flowers sessile. Calyx 5-lobed, 3.5–5 mm long, lobes equal, 2.5–4.5 mm long, 0.7–0.9 mm wide, abaxially and marginally pubescent with erect to flexuose eglandular trichomes 0.5–1 mm long. Corolla yellowish, 8.3–11.3 mm long, externally pubescent with erect to flexuose eglandular and glandular (sparse) trichomes 0.1–0.5 mm long, tube 4.2–5.5 mm long (not or scarcely expanded distally), 1.5–2.3 mm in diameter near midpoint, upper lip 4–5.3 mm long, apically 2-lobed, lobes 0.3–0.5 mm long, lower lip 4.5–6.5 mm long, lobes 1.2–2.5 mm long, 0.8–2.5 mm wide. Stamens 4.5–5 mm long, inserted near apex of corolla tube, thecae maroon, 1.1–1.4 mm long (including basal appendage), parallel, unequally inserted (overlapping by 0.2–0.3 mm), dorsally pubescent with eglandular trichomes, upper theca with a ± inconspicuous basal appendage to 0.2 mm long, lower theca with a blunt basal appendage 0.5–0.9 mm long; pollen (Fig. 2) 3-aperturate, apertures flanked on each side by 1 row of insulae or insulae absent and grains 6-pseudocolpate, exine reticulate. Style 7.5–8.5 mm long, proximally pubescent with eglandular trichomes, stigma 0.2 mm long, lobes not evident. Capsule 5.5–6.5 mm long, pubescent with erect to retrorse eglandular trichomes 0.1–0.4 mm long, stipe 1.9–2.5 mm long, head ellipsoid with slight medial constriction. Seeds (immature?) 4, plano-convex, 1.1 mm long, 1 mm wide, surfaces tuberculate.

Phenology.— Flowering: November–January; fruiting: November–January.

Distribution and habitat.— Yucatan Peninsula of Mexico (Quintana Roo; Fig. 3); plants occur in evergreen seasonal forests ("selva mediana subperennifolia") at elevations from near sea level to10 m.

Paratypes.— Mexico: **Quintana Roo**: Mpio. Felipe Carrillo Puerto, 19 km NW [NE] de F. Carrillo Puerto sobre el camino a Vigía Chico, *E. Cabrera 16968* (CIQR); Mpio. Felipe Carrillo Puerto, KM 20 carr. antigua de F. Carrillo Puerto a Vigía Chico, *Salazar C. 26* (CIQR).

The three known collections of this species each note a different color for the corolla (yellow for the type, blue for *Cabrera 16968*, and white for *Salazar C. 26*). It is possible that each characterization is at least partially correct, and like several other species of *Justicia* in the region, the corollas are cream to yellowish with bluish or purplish markings.

Among species of *Justicia*, *J. edgarcabrerae* appears related to a suite of heteromorphically bracteate American species that includes *J. chol* T.F. Daniel, *J. costaricana* Leonard, *J. nevlingii* Wassh. & T.F. Daniel, and *J. uxpanapensis* T.F. Daniel (Daniel 2002; Wasshausen and Daniel 1995). Among these species pollen varies from 2-aperturate (e.g., *J. uxpanapensis*) to 3-aperturate (e.g., *J. chol*) to 4-aperturate (e.g., *J. nevlingii*). *Justicia edgarcabrerae* is especially similar to *J. chol* which occurs in wetter forests of southern Mexico and has corollas that are white to cream-yellow with maroon markings (Daniel 1995). It differs from that species by the characters noted in the following couplet:

1a. Young stems quadrate to quadrate-sulcate; cauline trichomes with maroon septa; leaves with petioles to 35 mm long, blades acuminate at apex; calyx 2.5–3.5 mm long; corolla tube 5.5–7 mm long; stamens 3.5–4.5 mm long, thecae superposed (separated by a gap up to 0.5 mm long); rainforests of Chiapas and Tabasco . . . . *J. chol*

1b. Young stems subquadrate; cauline trichomes without maroon septa; leaves with petioles to 8 mm long, blades (rounded to) acute at apex; calyx 3.5–5 mm long; corolla tube 4.2–5.5 mm long; stamens 4.5–5 mm long, thecae unequally inserted (overlapping by 0.2–0.3 mm); evergreen seasonal forests of Quintana Roo . . . . *J. edgarcabrerae*

The epithet of this species is based on the name of the well known Mexican plant collector, Edgar Cabrera (see biographical information in Sousa S. and Cabrera C. 1983), whose fine specimens have enriched knowledge of the Yucatecan flora. Because of the existence of *J. cabrerae* Leonard, named for a different collector, we use both given and family names in this epithet.

***Justicia leucothamna* (Standl.) T.F. Daniel, Carnevali, and Tapia, comb. nov.**

Jacobinia leucothamna Standl., Field Mus. Nat. Hist., Bot. Ser. 8: 44. 1930.

TYPE.— MEXICO: **Yucatán**: Silam [= Dzilam González, see below], *G. Gaumer 1242* (holotype: F!).

Jacobinia Nees is usually included within *Justicia* (see Graham 1988), and a combination in the latter genus has not previously been made for this species. *Justicia leucothamna* is apparently known only by the six collections from the Yucatan Peninsula listed herein. Thus, it appears to be endemic to the Mexican portion of the Yucatán Peninsula (Fig. 3). The affinities of this species were not addressed by Standley in the protologue or by Leonard (1936) in a treatment of Acanthaceae of the Yucatan Peninsula. In many features (e.g., axillary, secund, and dichasiate spikes; four calyx lobes of equal length; whitish corollas; and contiguous but unequally inserted and dorsally pubescent thecae, the lower with a prominent basal appendage) the species resembles *J. salviiflora* H.B.K. of Graham's (1988) section *Sarotheca* (Nees) Benth. These species differ by the distinctions noted in the following couplet:

1a. Leaves to 85 mm long, to 43 mm wide, and 1.2–2.7 times longer than wide, apically acute- to rounded- to truncate-apiculate; calyx 3–5 mm long; corolla white with maroon markings, 9–12 mm long; capsule 8–12 mm long, glabrous . . . . *J. leucothamna*
1b. Leaves to 170 mm long, to 77 mm wide, and 1.5–4.4 times longer than wide, apically acute to acuminate to subfalcate; calyx 5.5–12 mm long; corolla greenish yellow tinged with pink and with maroon markings, 12–21 mm long; capsule 14–20 mm long, pubescent. . . *J. salviiflora*

Both of these species have 2-aperturate pollen with trema regions flanked on each side by one row of peninsulae or insulae (Fig. 2).

Martínez S. et al. 30861 occurs well to the south of other known collections of this species (Fig. 3). It was collected in a moister habitat ("selva mediana subcaducifolia") than the collections from northern Yucatán ("selva baja caducifolia"), and its stems and leaves are not as densely pubescent as in plants from the drier regions. On the basis of recent collections, Standley's (1930) description of *J. leucothamna* can be augmented as follows: corollas white with maroon markings on the lower lip (Fig. 4), 9–12 mm long; stamens 4–6.5 mm long, thecae maroon, 1–1.3 mm long; capsules 8–11.5 mm long, glabrous; seeds 4, 1.8–2.2 mm long, surface and margin densely tuberculate with conical tubercles.

The type locality of this species was cited by Gaumer as "Silam." Among his collections of Acanthaceae, Gaumer distinguished between "Silam" and "Port Silam." In addition, Millspaugh, who worked with Gaumer's collections, distinguished "Silam" from "the port of Silam" (Millspaugh 1896); and on his map of the Peninsula (Millspaugh 1896), "Silam" is shown interior to the coast. This certainly suggests that "Silam" refers to what appears on modern maps as Dzilam González, and that "the port of Silam" would refer to what appears on modern maps as Dzilam de Bravo (which is situated on the coast, ca. 15 km NE of Dzilam González). Thus the type locality would appear to be Dzilam González.

ADDITIONAL SPECIMENS EXAMINED.— MEXICO: **Campeche**: Mpio. Calakmul, 45 km NW de Conhuas, camino a Champotón, 18°49′N, 90°00′W, *E. Martínez S. et al. 30861* (CAS, MEXU). **Yucatán**:

Silam, *G. Gaumer 2280* (F, GH, MO); Mpio. Río Lagartos, pasando el Rancho Paraiso rumbo a Las Coloradas, 21°35′N, 88°10′W, *J. Leal & I. Espejel 223* (CICY); Mpio. San Felipe, 16 km después de Panabá rumbo a San Felipe, 21°26′N, 88°15′W, *J. Leal & V. Rico-Gray 111* (CICY); Mpio. Dzemul, km 6 de la carretera Dzemul–Xtampú, 4 km S del entronque a ruinas de Xtampú, 21°16.5′N, 89°18.5′W, *J.L. Tapia M. & M. Cházaro 1453* (CAS, CICY).

Acknowledgments

Daniel's field and herbarium studies were funded by a Franklin Grant from the American Philosophical Society in 2003; this award is gratefully acknowledged. We thank Meg Stalcup and Nadia Strasser for their fine botanical illustrations; Scott Serata for assistance with the scanning electron microscope; Lilia Can, Francisco Chi-May, Celso Gutiérrez, Silvia Hernández Aguilar, Gerald Islebe, and Filogonio May for their valuable assistance in the Yucatan Peninsula; and the curators of the following herbaria for access to their collections: BRIT, CAS, CICY, CIQR, F, GH, LL, MEXU, MO, UCAM. We also thank the reviewers for their thoughtful comments.

Literature Cited

Carnevali, G., I. Ramírez-Morillo, and J.A. González-Iturbe. 2003. Flora y vegetación de la Península de Yucatán. Pages 53–68 *in* P. Colunga García-Marín and A. Larqué Saavedra, eds., *Naturaleza y sociedad del Área Maya: pasado, presente y futuro.* Centro de Investigación Científica de Yucatán, Mérida, México.

Carnevali F., G., J.L. Tapia M., I.M. Ramírez M., R. Duno de Stefano, S. Hernández A., T.F. Daniel, F. Coe, J.J.J. Ortíz, N. Diego, L. Can I., and F. May P. 2005. Notes on the flora of the Yucatan Peninsula III: new records and miscellaneous notes for the peninsular flora II. *Harvard Papers in Botany* 9:257–296.

Daniel, T.F. 1995. Acanthaceae. Pages 1–158 *in* D.E. Breedlove, ed., *Flora of Chiapas, Pt. 4*. California Academy of Sciences, San Francisco, California, USA.

Daniel, T.F. 1997. The Acanthaceae of California and the peninsula of Baja California. *Proceedings of the California Academy of Sciences,* ser. 4, 49:309–403.

Daniel, T.F. 1999. Acanthaceae. *In* P. Dávila A. et al., eds. *Flora del Valle de Tehuacán-Cuicatlán, Fas. 23.* Instituto de Biología, UNAM, Cd. México.

Daniel, T.F. 2002. New and reconsidered Mexican Acanthaceae IX. *Justicia. Proceedings of the California Academy of Sciences*, ser. 4, 53:37–49.

Daniel, T.F. 2003. A reconsideration of *Megalostoma* (Acanthaceae), a new species, and recognition of a new section of *Justicia. Proceedings of the California Academy of Science*, ser. 4, 54:371–380.

Daniel, T.F. 2004. Acanthaceae of Sonora: taxonomy and phytogeography. *Proceedings of the California Academy of Sciences*, ser. 4, 55:690–805.

Daniel, T.F. 2005a. Catalog of Honduran Acanthaceae with taxonomic and phytogeographic notes. *Contributions from the University of Michigan Herbarium* 24:51–108.

Daniel, T.F. 2005b ("2004"). Further range extensions of Mexican Acanthaceae. *Polibotánica* 18:1–12.

Daniel, T.F., and S. Acosta C. 2003. Acanthaceae. Pages 1–173 *in* J. Rzedowski and G. Calderón de Rzedowski, eds., *Flora del Bajío, Fas. 117.* Instituto de Ecología, Centro Regional del Bajío, Pátzcuaro, Michoacán, México.

Graham, V.A.W. 1988. Delimitation and infra-generic classification of *Justicia* (Acanthaceae). *Kew Bulletin* 43:551–624.

Leonard, E.C. 1936. The Acanthaceae of the Yucatan Peninsula. *Publications of the Carnegie Institution of Washington* 461:193–238.

Millspaugh, C.F. 1896. Contribution II to the coastal and plain flora of Yucatan. *Field Museum of Natural History, Botanical Series* 1:277–340.

Sousa S., M. and E. Cabrera C. 1983. *Listados florísticos de México II. Flora de Quintana Roo.* Instituto de Biología, UNAM, Cd. México.

Standley, P.C. 1930. Studies of American plants–III. *Field Museum of Natural History, Botanical Series* 8:3–73.

Wasshausen, D.C., and T.F. Daniel. 1995. *Justicia nevlingii* (Acanthaceae), a new species from Mexico. *Novon* 5:114–117.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 32, pp. 619–623, 4 figs. December 30, 2005

Vanderhorstia bella, a New Goby from Fiji (Teleostei: Gobiidae)

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A single individual of a new goby species in the genus *Vanderhorstia* was collected from a fine sand bottom at Vanua Balavu Island, Bay of Islands, in the Northern Lau Group of Fiji. The species differs from all other described species in the genus except *V. mertensi* by having 17 dorsal and 18 anal-fin rays. It differs from *V. mertensi* by having about 77 versus 52-62 longitudinal scales and lacking a row of black spots the length of its midside. *Vanderhorstia bella* has much lavender coloration on the head and body and many bright yellow spots.

While conducting a survey of the fishes of Fiji, we collected a single individual of a spectacularly colored new goby in the genus *Vanderhorstia*. The specimen was collected using rotenone from a fine, silty, sand bottom at a depth of 8.3 m at Vanua Balavu Island, Bay of Islands, in the Northern Lau Group of Fiji.

The genus *Vanderhorstia* is represented by 12 described species, which are considered to be valid (Winterbottom et al. 2005).

Materials and Methods

All counts and measurements follow Winterbottom et al. (2005). Measurements were made to the nearest 0.1 mm using dial calipers and are expressed as percentage of standard length (SL). Dorsal pterygiophore formula and some other counts were taken from a radiograph. Format generally follows Winterbottom et al. (2005) for ease of comparison, and when characters are the same, their description is used. The holotype is deposited at the California Academy of Sciences (CAS).

Species Description

Vanderhorstia bella Greenfield and Longenecker, sp. nov.

Figs. 1–4.

Material Examined.— Holotype: CAS 222208, 70.9 mm SL, Fiji, Northern Lau Group, Vanua Balavu Island, Bay of Islands, 17°10.692′S, 179°00.887′W, fine, silty, sand with small coral patch, 8.3 m, 7 January 2003, field number G03-22, collected by D.W. Greenfield, K.R. Longenecker, and R.C. Langston.

Diagnosis.— A species in the genus *Vanderhorstia* with 17 segmented dorsal-fin rays, 18 segmented anal-fin rays, about 77 longitudinal scales, and a pointed caudal fin, lacking a row of black spots on its side, and having yellow spots on a lavender background on its head and anterior part of its body.

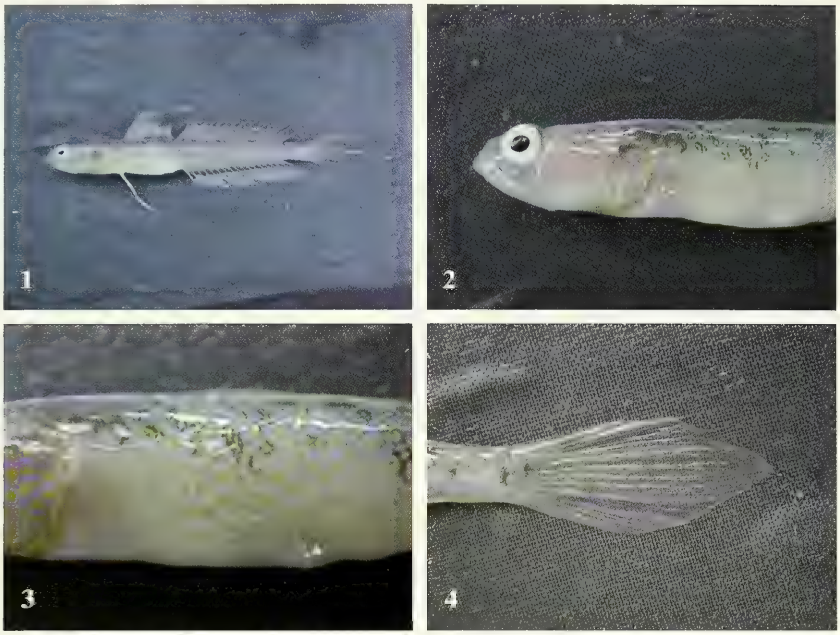
Description.— Dorsal-fin elements VI-I,17, all rays branched; anal-fin elements I,18, all rays branched; pectoral-fin rays 18, upper and lowermost rays unbranched; pelvic-fin elements I,5; segmented caudal-fin rays 17, 9 dorsal + 8 ventral branched rays; dorsal unsegmented (procurrent) caudal-fin rays 7; ventral unsegmented (procurrent) caudal-fin rays 7; longitudinal scales about 77; transverse scale rows from anal-fin origin anterodorsally to first dorsal-fin base 20; transverse scales from anal-fin origin posterodorsally to second dorsal-fin base 17; predorsal scales absent in midline; scales beginning above pectoral-fin base extend posteriorly to insertion of first dorsal fin; circumpeduncular scales 12; no scales on pectoral-fin base; scales on prepelvic region embedded and difficult to count; gill rakers 4 + 16 on outer surface of first arch; vertebrae 10 + 16; dorsal pterygiophore formula 3 (2,2,1,1); epural 1; anal-fin pterygiophores anterior to first haemal spine 2; pleural ribs on third to tenth precaudal vertebrae.

The following measurements are expressed as % SL: head length 25.2; head width 9.4; head depth 13.1; snout length 3.7; eye diameter 5.5; interorbital width 2.0; nape width 7.4; jaw length 11.1; body depth at origin of first dorsal fin 13.1; body depth at origin of anal fin 11.2; body width 7.3; predorsal length 29.1; prepelvic length 27.5; preanal length 51.7; caudal-peduncle length 11.9; caudal-peduncle depth 7.3; length of first dorsal-fin base 19.5; length of second dorsal-fin base 41.8; pectoral-fin length 28.2; pelvic-fin length 24.0; length of first dorsal-fin spine 18.3; length of second dorsal-fin spine 17.5; length of third dorsal-fin spine 16.7; length of fourth dorsal-fin spine 27.1; length of fifth dorsal-fin spine 22.4; length of sixth dorsal-fin spine 16.4; length of spine of second dorsal fin 8.9; length of first segmented ray of second dorsal fin 12.4; length of longest segmented ray of second dorsal fin (= 4^{th}) 13.7; length of anal-fin spine 7.9; length of first segmented ray of anal fin 10.2; length of longest segmented ray of anal fin (= 5^{th}) 15.1; length of pelvic-fin spine 7.1; length of first segmented ray of pelvic fin 11.5; length of fifth segmented ray of pelvic fin 21.6; caudal-fin length 37.1.

Body elongate and compressed. Head slightly compressed, its width 71.7% of depth. Snout very short, its length 67% of eye diameter; snout does not protrude beyond upper lip. Eye dorsolateral, moderately large, its diameter 22.0% of head length; interorbital space narrow its width narrower than pupil diameter and 8.1% of head length. No distinct, deep trough around eyes from interorbital to postorbital regions. No cutaneous ridge along dorsal midline of nape. Gape moderately oblique, forming an angle of about 28° with body axis. Lower jaw projecting anteriorly beyond upper jaw; posterior end of jaws reach to slightly behind posterior eye margin; jaw length 43.9% of head length.

Anterior nasal opening a short tube, with the posterior edge slightly longer than the anterior edge; posterior nasal opening a large pore, located adjacent to eye. Tip of tongue rounded, anterior portion free from floor of mouth. Posteroventral margin of lower lip entire, no mental flap on chin. Gill opening wide, extending anteriorly to vertical line through posterior margin of pupil of eye; gill membranes attach to very narrow isthmus; no distinct free rear margin. No fleshy projections on lateral wing of shoulder girdle. No bony projections along posterior margin of preopercle.

Caudal peduncle moderately slender, its depth 61.3% of caudal-peduncle length. First dorsal fin higher than second dorsal fin; first dorsal fin close to, but not connected to second dorsal fin by membrane; fourth spine of first dorsal fin longest, 155.4% of second spine length, not filamentous; all dorsal spines slender and flexible; fourth segmented ray of second dorsal fin longest. Origin of anal fin on vertical base with first segmented ray of second dorsal fin; height of anal fin slightly higher than second dorsal fin; anal-fin spine slender and flexible; fifth anal-fin ray longest. Pectoral fin nearly lanceolate, reaching posteriorly to vertical line through base of second dorsal fin between spine and first segmented ray; upper and lowermost pectoral-fin rays unbranched, the remainder branched. Origin of pelvic fin about midway between posterior edge of opercular membrane and



FIGURES 1–4 (CAS 222208); Holotype of *Vanderhorstia bella*. (1) Full lateral view; (2) Closeup of head and anterior portion of body; (3) Closeup of anterior body showing distinctive color markings; (4) Closeup of caudal fin.

dorsal-fin origin; pelvic fins joined medially by well-developed frenum (between spines) and interradial membrane (between innermost segmented rays); pelvic frenum moderately thin, with smooth posterior margin; all segmented pelvic-fin rays branched.

Head scaleless, including predorsal; scales cycloid on anterior part of body back to about tips of pectoral fins, becoming larger and ctenoid with peripheral cteni posteriorly; no scales on pectoral-fin base; scales overlying basal region of caudal fin all ctenoid.

Teeth in both jaws unicuspid; upper jaw with outer row of spaced, enlarged, curved caniniform teeth and an inner row of small similar teeth, teeth near symphysis enlarged and point posteriorly; lower jaw with 1–3 enlarged, curved, spaced, caniniform teeth, two irregular rows of smaller teeth medially grading into a single row posteriorly, an innermost row of 2–3 much enlarged curved, spaced canines at bend of dentary; no teeth on vomer or palatine.

Cephalic sensory systems: pore pattern as in *Vanderhorstia nannai* (Winterbottom 2005, Fig. 3). All cephalic sensory-papillae rows uniserial, not forming multiple rows; relatively reduced longitudinal pattern of sensory papillae rows on cheek; row *a* short and reduced, with about four sensory papillae; row *b* very short, extending back from row *a* to about one-third distance to preopercle; row *d* extending back just past end of maxilla.

Color of fresh specimen: Background color white, overlaid by lavender in many areas. Side of head bright, iridescent lavender covered with many small (about one-third pupil diameter) round, bright yellow spots extending from eye back onto pectoral-fin base. Snout and jaws white with a slight lavender tinge. A black line in fold between premaxilla and maxilla anterior to eye. Pupil black, iris silver with tinges of yellow. Lower side of head white, top of head and nape lavender. Sides of body with lavender tinge on upper half (less intense than on head), white on lower half; upper half covered with irregularly-shaped yellow spots edged in black; lower half with smaller yellow spots without black edges; a series of 13 irregular black vertical lines on midside below sec-

ond dorsal fin; a series of 10 dark blotches running from middle of first dorsal-fin base to caudal peduncle. Pectoral and pelvic fins clear. First dorsal fin light yellow. Second dorsal and anal fins light yellow with distal lavender margins. Caudal fin with light yellow rays and lavender membranes in between.

Color in alcohol: Background color cream. Top of snout and anterior portion of premaxilla and maxilla dusky, posterior part of jaws cream, a distinct black line between premaxilla and maxilla, anterio-ventral to eye. Side of head and pectoral-fin base with numerous round light spots; pupil of eye black, iris silver with black dorsal margin. Top of head and nape with scattered small brown spots, upper half of body with irregular small light spots surrounded with dark pigment; lower half of body and breast cream. Caudal, anal and pelvic fins peppered with small dark pigment spots; pectoral fins immaculate; first and second dorsal fins peppered with small dark spots and with small round light spots.

Etymology.— From the Latin *bellus*, an adjective meaning beautiful, referring to the striking coloration of the species.

Comparisons.— *Vanderhorstia bella* is in the subfamily Gobiinae because it has a single anterior pore in the interorbital area, the lower jaw has more than one row of teeth, both the dorsal and anal fins are separate from the caudal fin, and the two dorsal fins are separate. The fish keys to the genus *Vanderhorstia* in Larson and Murdy (2001) because of the following features: 1a. First gill slit open; 2b. Body scaled; 8b. No dermal crest anterior to first dorsal fin; 11b. No barbels on underside of head; 16b. Dorsal-fin spines thin and flexible; 21b and 22b. Preopercle lacking spines; 23b. Dorsal-fin origin behind pectoral-fin base; 24b. Cheeks without prominent vertical fleshy flaps bearing papillae; 25b. Pelvic fins without fleshy frenum folded forward; 30b. Chin without mental frenum; 34b. Head without fine fleshy flaps and bumps; 35b. Head pores present; 39b. Pelvic fins completely connected by membrane; 43b. Mouth not small and vertical; 44b. Cheeks and operculum naked; 48a. Gill opening extending forward to rear margin of eye; 49b. Head papillae in a longitudinal pattern; 50a–50b. There is one more anal than dorsal-fin ray, which would key to *Silhouettea*, but because of its very short snout, pointed caudal fin, approximately 77 longitudinal scales, smooth-edged frenum, and rounded tongue it clearly does not fit the diagnosis of Larson and Miller (1986). Also, other *Vanderhorstia* species have more anal than dorsal-fin rays (e.g., *V. mertensi*), thus the key is in error and 50b. was chosen; 51b. No iris lappet and tongue not deeply bilobed; 52b. Second dorsal fin and anal fin with 1 spine and more than 10 soft rays; 53b. No distinct black ocellus in each dorsal fin; 54b. Caudal fin pointed, longer than head, body with spots, and no bright white spot on pectoral fins = *Vanderhorstia*. As pointed out by Shibukawa and Suzuki (2004), there are no derived characters supporting monophyly of *Vanderhorstia*, and it is separated from *Ctenogobiops* only by caudal-fin length and coloration.

The number of segmented dorsal and anal-fin rays of *V. bella* is high (D. 17, A. 18) compared to all other described species except *V. mertensi* Klausewitz which has 16 dorsal-fin rays and 17–18 anal-fin rays. All other described species have 10–14 dorsal-fin rays and 10–14 anal-fin rays. *Vanderhorstia bella* differs from *V. mertensi* by lacking its distinctive row of black spots that extend down the middle of its sides from the opercle to the caudal peduncle, and by having about 77 versus 52–62 longitudinal scales. Its high longitudinal scale count also separates it from all other species except *V. ambanoro* (Fourmanoir). It also differs in its distinctive coloration from all described and photographs of undescribed species in the literature.

Because the holotype was collected in a general rotenone station, we do not know if it associates with a shrimp or lives in a burrow; however, many other species in the genus *Vanderhorstia* do. The radiograph of the specimen showed that it had one clam and one snail in its stomach, suggesting that it may feed on items brought up by a shrimp.

Acknowledgments

We would like to thank R.C. Langston for assistance in collecting specimens, and Captain B. Vasconcellos and the crew of the *Moku Mokua Hine* for assistance in the field. We are grateful to J. Seeto, G.R. South, R.R. Thaman, and R.W. Tuxton of the University of the South Pacific, Fiji for facilitating our collecting in Fiji. We also thank the Fijian Government and local village chiefs for permission to collect fishes. Special thanks to the staff at CAS for providing assistance: D. Catania, W.N. Eschmeyer, J. Fong, M. Hoang, T. Iwamoto, as well as an anonymous reviewer. This research was supported by National Science Foundation grants INT97-29666 and DEB0-1027545, and Sea Grant Project R/FM-6PD.

Literature Cited

Larson, H.K. and P.J. Miller. 1986. Two new species of *Silhuettea* (Gobiidae) from Northern Australia. *Japanese Journal of Ichthyology* 33(2):110–118.

Larson, H.K. and E.O. Murdy. 2001. Gobiidae. Pages 3578–3603 *in* K.E. Carpenter and V.H. Niem, eds., *FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific. Volume 6. Bony Fishes, part 4 (Labridae to Latimeriidae), Estuarine Crocodiles, Sea Turtles, Sea Snakes and Marine Mammals.* FAO, Rome, Italy.

Shibukawa, K. and T. Suzuki. 2004. *Vanderhorstia papilio*, a new shrimp-associated goby from the Ryukyu Islands, Japan (Perciformes: Gobiidae: Gobiinae), with comments on the limits of the genus. *Ichthyological Research* 51:113–119.

Winterbottom, R., A. Iwata, and T. Kozawa. 2005. *Vanderhorstia nannai*, a new species of burrow-associated goby from Palau and the Philippines (Pisces: Gobiidae). *Aqua, Journal of Ichthyology and Aquatic Biology* 9 (3):109–114.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 33, pp. 625–637, 6 figs., 3 tables. December 30, 2005

Two New Cardinalfishes of the Indo-Pacific Fish Genus *Zoramia* (Apogonidae)

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Two new species of *Zoramia* (formerly a subgenus of *Apogon*) are described. *Zoramia flebila*, described from Fiji, has blue spots on the sides, blue teardrop-shaped marks under the eyes, and two narrow yellow lines on the midside. It also has a small spot surrounded by diffuse melanophores on the caudal peduncle, and lacks an opercular spot and dark vertical lines above the anal-fin rays. It has scattered melanophores on the breast, pelvic fins, and the entire second dorsal fin, and a line of dark pigment along the anal-fin base. There are 27–30 gill rakers, usually 28 or 29. *Zoramia fragilis*, previously thought to range from the Indian Ocean into the Pacific, was shown to consist of two species; *Z. fragilis* restricted to Mozambique, Madagascar, and the Seychelles, and those in the Pacific Ocean a separate species here described as *Z. viridiventer*. These two species are separated by the number of gill rakers and dorsal and anal-fin spine length.

Fraser (1972) divided the apogonid fish genus *Apogon* Lacepède into ten subgenera, mainly on osteological characters. The subgenera *Pristiapogon* and *Zoramia* Jordan were revised by Fraser and Lachner (1985), who recognized four species within *Zoramia* Jordan: *A. leptacanthus* Bleeker, the type species, wide-ranging from the east coast of Africa to the Samoa Islands; *A. fragilis* Smith with a disjunct population, one from Mozambique (type locality), Madagascar, and the Seychelles, and the other from Indonesia and the Philippines to the Marshall Islands and Samoa Islands; *A. gilberti* (Jordan and Seale) from the Philippines, Sabah, and Indonesia, east to Palau and Yap; and *A. perlitus*, described as a new species from Palau, Papua New Guinea, Molucca Islands, and the Philippines.

Rodman-Bergman (2004) reviewed the generic and subgeneric classification of the Apogonidae. Using external morphology, skeletal characters and a detailed study of the cephalic lateralis system, she concluded that *Apogon* is an unnatural taxon: "Every cladogram generated in these analyses showed that the subgenera of these two taxa (*Apogon* and *Pterapogon*) were more closely related to other genera, than they were to one another." Based on her findings we are treating the subgenus *Zoramia* of Fraser (1972) as a genus.

While conducting a survey of the fishes of Fiji, we collected individuals of a species of *Zoramia* that we did not recognize. The specimens were similar in color to *Z. gilberti*, but lacked the spot on the opercular flap and have distinctive blue teardrop-like marks on the cheek and blue spots on the side of the body above the pectoral fin. In checking comparative material of other species of *Zoramia*, we discovered that the eastern population identified as *Zoramia fragilis* is a

distinct species. The purpose of this paper is to describe these two new species of cardinalfishes. We present first the diagnosis of *Zoramia* based primarily on Fraser and Lachner (1985), followed by a revised key to the species of the genus and the descriptions of the two new species.

Materials and Methods

Data for the holotype are presented first, followed by the range and mean or mode for all specimens in parentheses. Measurements were made to the nearest 0.1 mm using dial calipers and are expressed as percentage of standard length (SL). Methods of making counts and measurements follow Fraser and Lachner (1985), except for body depth, which was taken vertically from below the origin of the dorsal fin (their measurement from the origin of first dorsal spine to the insertion of the pelvic spine is slightly oblique). We also added body width (taken just behind the gill opening), predorsal, preanal, and prepelvic lengths, lengths of dorsal- and anal-fin bases, and caudal concavity, the horizontal distance between the tips of the longest and shortest caudal rays. A microscope is needed to see scattered melanophores described in the key for *Z. flebila*.

The spines and especially the soft rays of the fins of the species of *Zoramia* are very fragile and often found broken. It is unusual to have a specimen with fully intact fins among older lots of museum specimens. Longest caudal-fin ray and caudal concavity measurements of the holotypes were taken from photographs in the field before fin rays were broken. The third dorsal-fin spine is broken in the holotype of *Z. flebila*. Lateral-line scales often are lost. Eye size as percentage standard length versus standard length for *Z. flebila* and *Z. gilberti* was tested with a two-sample T-test (Fig. 3). Specimens used in figure two were from both some of the types and also CAS 2223156. Except for *Z. flebila*, *Z. viridiventer*, and *Z. fragilis*, gill raker counts in Table 2 are from Fraser and Lachner (1985). Measurements for *Z. viridiventer* were taken from nine BPBM specimens. Specimens of the new species have been deposited in the Australian Museum, Sydney (AMS); Natural History Museum, London (BMNH); Bishop Museum, Honolulu (BPBM); California Academy of Sciences, San Francisco (CAS); Field Museum of Natural History, Chicago (FMNH); University of Kansas (KU); National Science Museum, Tokyo (NSMT); South African Institute for Aquatic Biodiversity, Grahamstown (SAIAB); and the U.S. National Museum of Natural History, Washington, D.C. (USNM).

Genus *Zoramia* Jordan, 1917

Zoramia Jordan, 1917: 46 [type species *Apogon graeffi* Günther, 1873, by original description (also monotypic) = *Apogon leptacanthus* Bleeker, 1856].

Diagnosis.— Dorsal rays VI–I,9; anal rays II,9; pectoral rays 13–15 (usually 14); pelvic rays I,5; scales finely ctenoid; lateral line complete to caudal-fin base, the pored scales 23–24; median predorsal scales 6; scales of body not smaller than lateral-line scales; gill rakers 24–32; branchiostegal rays 7; vertebrae 10 + 14; supraneural (predorsal) bones 3; mouth very oblique, the lower jaw strongly projecting; supramaxilla absent; posterior end of maxilla with a distinct notch; maxilla with a longitudinal ridge ending just before angle of posterior notch; jaws with two rows of very small conical teeth anteriorly, narrowing to one row posteriorly; a single row of very small teeth on vomer and palatines, none on ectopterygoids; preopercular ridge smooth, the edge finely serrate, becoming smooth dorsally on posterior limb; infraorbitial edge smooth; posttemporal smooth; body depth moderately deep, 2.1–4.0 in standard length (juveniles more slender, in general), and strongly compressed, the maximum width 2.5–3.4 in body depth; caudal fin moderately forked; no black stripes (though there may be a dark line along dorsal edge of body); digestive tract black.

Key to the Species of *Zoramia*

1a. No black spot on caudal peduncle; second dorsal spine very long and filamentous, 34–66% SL (at SL of 23 mm or more), the third and fourth spines also prolonged (east coast of Africa to Samoa Islands) . . . . *Z. leptacantha* (Fig. 1A)
1b. A small black spot midposteriorly on caudal peduncle; second dorsal spine not very long and filamentous (except adults of *Z. flebila* and *Z. gilberti*, but spine length less than 36% SL). 2

2a. A prominent to diffuse dark spot posteriorly on opercle; total gill rakers 28–32 (Philippines, Indonesia, and western Caroline Islands) . . . . *Z. gilberti* (Fig. 1B)
2b. No dark spot posteriorly on opercle; total gill rakers 24—30 3

3a. Four to eight short vertical dark lines above anterior half of anal-fin (Philippines, Indonesia, Papua New Guinea, and Palau. . . . . *Z. perlita* (Fig. 1F)
3b. No vertical dark lines above anal-fin base. 4

4a. Basicaudal black spot surrounded by a dusky to blackish zone; entire second dorsal fin, breast, and pelvic fins with scattered melanophores (microscope needed); a line of melanophores running along anal-fin base on body; second dorsal-fin spine 21.8–35.2% SL; body depth usually greater than 40% SL (Fiji) . . . . *Z. flebila*, sp. nov. (Fig. 1C, 2)
4b. Basicaudal black spot not within a dusky to blackish zone on caudal peduncle; posterior half of second dorsal fin, breast, and pelvic fins lacking scattered melanophores; no line of melanophores running along anal-fin base on body; second dorsal-fin spine 18.9–24.8% SL; body depth usually less than 40% SL 5

5a. Gill rakers 27–30; second dorsal-fin spine 21.5–24.8% SL; second anal-fin spine 15.1–17.9% SL (Mozambique, Madagascar, and Seychelles) . . . . *Z. fragilis* (Fig. 1D)
5b. Gill rakers 24–27; second dorsal-fin spine 18.9–21.7% SL; second anal-fin spine 13.0–15.9% SL (Philippines to Queensland, east to Marshall Islands and Samoa Islands) . . . . *Z. viridiventer*, sp. nov. (Fig. 1E, 4–6)

Species Descriptions

Zoramia flebila Greenfield, Langston, and Randall, sp. nov.
Figs. 1C, 2, Tables 1–2.

Material Examined.— Holotype: CAS 222057, 40.2 mm SL, Fiji, Northern Lau Group, Vanua Balavul Island, Bay of Islands, 17°10.692′S, 179°00.887′W, sand with small coral patch, 8.3 m, 7 January 2003. field number G03-22, collected by D. W. Greenfield, K. R. Longenecker, and R. C. Langston. Paratypes: BPBM 40152, 38.4 mm SL, collected with holotype; USNM 383148, 35.1 mm SL, collected with holotype; CAS 222155, 34.6–39.5 mm (3), Fiji, Vanua Levu, north shore, Great Sea Reef, southwest of Kia Island, 16°18.591′S, 179°02.129′E, isolated coral head in fine sand, 10.8-11.5m, 27 March 2002, field number G02-109, collected by D. W. Greenfield, K.R. Longenecker, R. C. Langston, and B. K. Mataitini; FMNH 116455, 43.6 mm, collected with CAS 222155; BM(NH) 2005.4.25.1, 39.3 mm, collected with CAS 222155; AMS I.43576-001, 36.4 mm, collected with CAS 222155; NSMT-P70721, 41.5 mm, collected with CAS 222155; SAIAB 75633, 36.1 mm, collected with CAS 222155; BPBM 40153, 33.3 mm, collected with CAS 222155; USNM 383149, 40.4 mm, collected with CAS 222155. Additional Material Examined: *Zoramia flebila*, CAS 222156 (112), CAS 219847 (1 –DNA = 4024), KU 31970 (1–DNA = 4020), all collected with paratypes CAS 222155. *Zoramia gilberti*: Western Caroline Islands, Yap Island, CAS 83496 (50), CAS 28780 (40), CAS 28780 (1), Palau, CAS 85911 (4). *Zoramia viridiventer*: Solomon Islands, CAS 167414 (9). *Zoramia leptacantha*: Yap Island, CAS 84415 (2), Palau, CAS 84399 (2), Fiji, CAS 222157 (39). *Zoramia*

perlita: Palau, CAS 30740 (5) paratypes, CAS 30745 (1) paratype. *Zoramis fragilis*: Madagascar, USNM 211839 (9).

Diganosis.— A species in the genus *Zoramia* with no distinct dark line on the dorsum from the first dorsal-fin origin onto the caudal peduncle; no dark lines above insertion of anal-fin rays; opercular flap lacking a prominent or diffuse dark spot; caudal spot small, surrounded with many diffuse melanophores on caudal peduncle; a peppering of melanophores on the breast and pelvic fins, and all of the second dorsal fin; distinct blue teardrop-like marks on cheek; blue spots on side above pectoral fin; two narrow yellow lines on midside; an iridescent blue line along anal-fin base; total developed gill rakers 27–30, usually 28 or 29; second dorsal-fin spine 21.8–35.2 % SL; body depth 39.7–47.2% SL.

Description.— Dorsal-fin elements VI–I, 9; anal-fin elements II,9 last dorsal and anal-fin rays branched to base; pectoral-fin rays 13 (13–14, usually 14), uppermost two and lower two or three unbranched; pelvic-fin rays I,5, all branched; principal caudal-fin rays 17, upper and lower unbranched; well-developed gill rakers 21 + 7 (21–23, usually 22 + 6–7, usually 6, total 27–30, usually 28 or 29); pored lateral-line scales 24; transverse scale rows above lateral line 2; median predorsal scales 6; circumpeduncular scales 12.

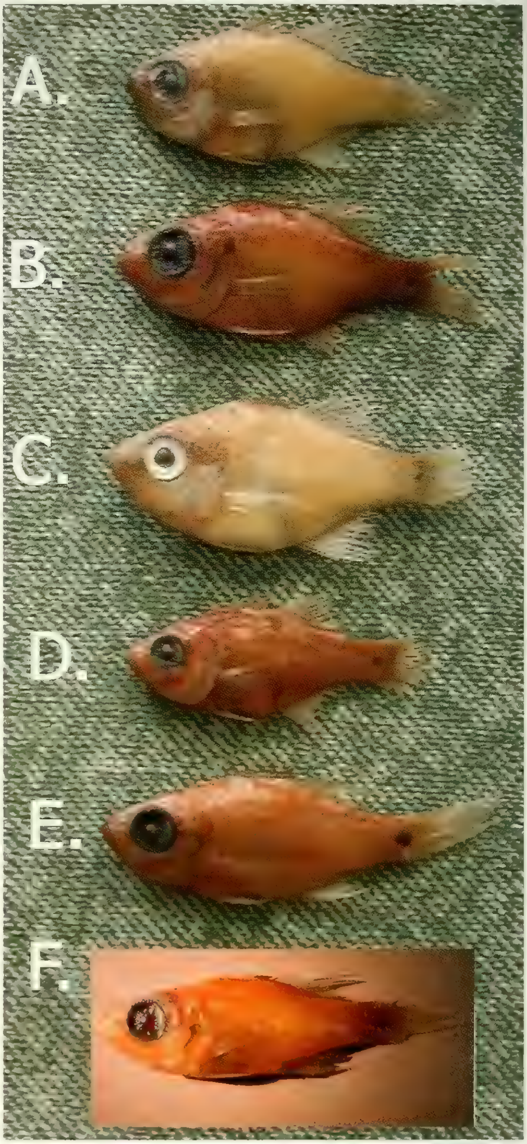

Figure 1. Preserved *Zoramia* specimens: 1A: *Z. leptacantha*, CAS 222157; 1B: *Z. gilberti*, CAS 85914; 1C: *Z. flebila*, CAS 222057 (Holotype); 1D: *Z. fragilis* USNM211839; 1E: *Z. viridiventer*, CAS84689; 1F: *Z. perlita*, CAS30740 (Paratype).

Proportions (as percent SL; also see Table 1): Body depth 47.2 (39.7–47.2; 44.1); head length 39.7 (38.1–41.8; 40.0); eye length 14.8 (14.4–15.7; 15.2); snout length 9.8 (6.8–9.8; 7.9); bony interorbital width 8.8 (8.4–9.7; 9.2); upper jaw length 18.9 (17.7–20.3; 18.8); caudal-peduncle depth 17.1 (15.4–19.0; 16.8); caudal-peduncle length 23.0 (18.8–28.5; 24.6); predorsal-fin length 37.3 (36.6–41.2; 38.9); base of first dorsal fin 19.0 (14.9–19.0; 17.4); dorsal-spine lengths—first 10.1 (10.1–14.8; 12.4), second 35.2 (21.8–35.2; 27.3), third [broken in holotype, not measured] (19.0–23.2; 21.9), fourth 21.0 (16.6–23.6; 19.7), fifth 15.5 (11.5–15.7; 13.6), sixth 8.1 (6.8–9.2; 8.0); base of second dorsal fin 20.6 (17.4–24.5; 21.6); spine in second dorsal fin 14.9 (14.9–21.1; 18.0); longest dorsal ray 26.6 (26.6–29.2; 28); preanal length 60.1 (55.4–63.9; 60.6); base of anal fin 23.7 (20.3–24.0; 22.4); anal-spine lengths—first 4.8 (4.3–5.8; 4.9), second 13.0 (13.0–16.2; 14.9); longest anal ray broken (25– 27.5; 26.5); pectoral-fin length

28.3 (24.8–31.1; 26.1); prepelvic length 31.8 (31.2–41.0; 35.4); pelvic-fin spine 15.1 (15.1–20.8; 18.3); pelvic-fin length 26.1 (24.6– 30.0; 26.2).

FIGURE 2. Holotype of *Zoramia flebila*, CAS 222057.

Body depth 2.1 (2.1–2.5) in SL; body compressed, the width 2.8 (2.8–3.4) in body depth; dorsal profile of head straight; snout length 4.0 (4.0-5.9) in head length; orbit diameter 2.7 (2.5–2.8) in head length; bony interorbital width 4.5 (4.1–4.7) in head length; caudal-peduncle depth 2.3 (2.1–2.7) in head length; caudal-peduncle length 1.7 (1.4–2.3) in head length.

Mouth very oblique, forming an angle of about 50° to horizontal axis of head, the lower jaw strongly projecting; maxilla extending to below center of eye, the upper-jaw length 2.1 (1.9–2.4) in head length; posterior end of maxilla with a distinct angular notch; dentition as in the genus. Tongue narrowly triangular with rounded tip, the upper surface with small papillae. Gill rakers well developed, the longest on lower limb nearly half orbit diameter in length. Anterior nostril a small, short, membranous tube on side of snout, slightly more than half distance from fleshy edge of orbit to median anterior point of upper lip; posterior nostril a narrow elliptical opening at level of upper edge of pupil, its length about one-fourth pupil diameter.

Suborbital margin smooth, ending below center of eye; preopercular ridge smooth; posterior three-fourths of ventral edge of preopercle and ventral one-quarter of posterior edge finely serrate.

Color of fresh specimen: Top of head and back greenish gray, overlaid with scattered, small melanophores. Two parallel, narrow, yellow lines running along midside from opercle to caudal peduncle. Area below yellow lines lighter than dorsum, silvery under pectoral fins and on belly, a bluish tinge on area above anal fin. Scattered bluish spots above pectoral fin, overlaying yellow lines. Caudal peduncle with heavy concentration of melanophores, forming a dark band at caudal-fin base. A small black spot at center of band. Area below eye, preopercle and opercle silvery, extending back to join silvery belly. Four relatively large teardrop-shaped blue marks under and behind eye, with several more spots extending up along opercular margin. Snout dark green, tip of lower jaw with reddish tinge. Pupil of eye black, iris silvery with a greenish band running horizontally across it at pupil. First two dorsal-fin spines with a reddish tinge, remainder of dorsal fin greenish yellow. Pelvic fins reddish. Caudal fin clear except for greenish dorsal and ventral margins at base. Anal fin clear with a black band along its base and an iridescent blue line next to it on the body. Pectoral fins clear. Often coloration that is blue in life may turn a pink color after the fish is dead but still fresh, thus the color in Figure 2 looks pink. Another photograph of the two DNA specimens shows a blue color.

Color in alcohol: Head and body straw yellow. Top of head and sides of body, except area under and below pectoral fin, covered with tiny, scattered melanophores. Melanophores more concentrated on caudal peduncle, forming a band. A small black spot about half a pupil diameter centered on side of band. Area under eye, preopercle and opercle lacking pigment. Snout and lower jaw with scattered melanophores. Area between isthmus and insertion of pelvic fins with scattered melanophores. Pupil of eye dark, surrounded by silvery iris. First and second dorsal, caudal, and pelvic fins covered with scattered melanophores. Anal fin clear except for a row of melanophores along its base. Pectoral fins clear.

TABLE 1. Proportional measurements of type specimens of *Zoramia flebila* as percentage of standard length.

	Holotype	Paratypes											
	CAS 222057	CAS 222155	CAS 222155	CAS 222155	BPBM 40152	BPBM 40153	BM(NH) 2005.4.25.1	USNM 383149	USNM 383148	FMNH 116455	AMS I.43576-001	NSMT P70721	SAIAB 75633
Standard length (mm)	40.2	34.6	36.4	39.5	38.4	33.3	39.9	40.4	35.1	43.6	36.4	41.5	36.1
Body depth	47.2	39.7	45.3	46.2	45.9	42.8	45	46.3	40.7	45.6	41.2	44.3	43.5
Body width	16.9	13.7	14.8	13.9	14.9	14.6	14.4	15.1	14.7	14.7	13.3	15.5	12.7
Head length	39.7	39.7	40.3	40.6	38.1	38.6	41.8	38.7	39.6	41.4	38.9	41.4	41.4
Snout length	9.8	7.5	8.1	6.8	8.1	7.8	8	7.3	8	7.1	8.2	7.6	8.4
Orbit diameter	14.8	15.6	15.1	15.6	14.7	15.3	15.3	15.3	15.2	15.6	14.8	15.7	15.5
Interorbital width	8.8	8.4	8.6	9	9.1	9.6	9.5	9.4	9.3	9.6	9.2	9.6	9.7
Upper-jaw length	18.9	17.8	19.6	18	17.9	18.5	18.9	20.2	17.7	19.9	18.7	19.4	18.8
Caudal-peduncle depth	17.1	15.6	16.7	17	18.2	17.3	17.4	16	16.1	16.3	16.5	16.7	15.4
Caudal-peduncle length	23	28.5	26.1	25.1	26	26	26.4	16.6	20.2	24.4	26.2	22.3	26.9
Predorsal length	37.3	36.6	39.5	39.2	37.2	40.2	38.8	41.2	37.7	40.9	39.1	39.6	37.9
Base of first dorsal fin	19	18.2	18.1	14.9	18.2	16.1	18.3	14.6	16.1	16.5	17.9	17.3	16.3
First dorsal-fin spine	10.1	12.1	14.8	13.3	13.3	10.5	broken	12.4	broken	Broken	11.4	13.7	13.7
Second dorsal-fin spine	35.2	broken	broken	22.7	29.6	21.8	25.1	31.2	broken	24.6	27.5	broken	28.2
Third dorsal-fin spine	broken	broken	broken	24.9	19	broken	23.2	21.5	broken	Broken	19.9	broken	22.7
Fourth dorsal-fin spine	21	broken	23.6	17.7	21.5	18.3	broken	19.8	broken	Broken	19	broken	16.6
Fifth dorsal-fin spine	15.5	broken	broken	15.7	14	13.2	14	11.5	12.7	Broken	14.4	12.3	13
Sixth dorsal-fin spine	8.1	broken	9.2	8.6	7.4	7.9	7.3	4.9	6.8	8.1	8.2	8.9	broken
Base of second dorsal fin	20.6	23.4	24.5	23.7	20	21.9	20.9	23.3	21.1	19.2	21.3	23	17.4
Second dorsal-fin spine	14.9	broken	21.1	19.5	16.6	18.3	18.5	broken	16.5	16.2	19.5	17.6	19.1
Longest dorsal ray	26.6	27.2	29.2	broken	broken	28.7	28.3	broken	broken	Broken	broken	broken	broken
Preanal length	60.1	60.2	63.8	61.2	61.6	55.4	60.8	63.9	57.8	61.5	60.2	59	62.6
Base of anal fin	23.7	22.7	23.4	23.3	21.3	22.2	22.2	20.3	22.2	22.7	24	22.2	20.9
First anal-fin spine	4.8	5.2	5.8	4.8	4.8	5.4	4.4	4.4	4.3	4	4.8	5.8	5
Second anal-fin spine	13	13.9	16.2	16.2	14.6	15.6	15.4	15.3	14.7	13.6	15.4	14.9	15.2
Longest anal ray	broken	27	broken	27.1	25	25.5	27	broken	broken	Broken	27.5	broken	broken
Caudal-fin length	33.2	broken	broken	broken	broken	broken	broken	broken	broken	Broken	broken	broken	broken
Caudal concavity	7.6	broken	broken	broken	broken	broken	broken	broken	broken	Broken	broken	broken	broken
Pectoral-fin length	28.3	30.8	30.2	31.1	27.8	28.5	28.9	29.2	26.5	29.4	28.3	27.7	30.5
Prepelvic length	31.8	31.3	37.3	37	31.2	35.6	36.6	38	32.8	37	33.6	36.9	41
Pelvic spine	15.1	17.5	17.6	19	15.6	15.6	20.2	20.8	17.1	18.8	19.5	17.1	18.3
Pelvic-fin length	26.1	24.8	26.4	30	26.8	25.5	26.4	26.2	24.6	26.4	25.1	27.1	25.9

TABLE 2. Total gill-raker counts for species of *Zoramia*. Counts are from Fraser and Lachner (1985), except for *Z. flebila, Z. fragilis,* and *Z. viridiventer.*

	24	25	26	27	28	29	30	31	32
Z. flebilia				8	12	12	1		
Z. fragilis				1	7	28	2		
Z. gilberti					10	27	19	7	2
Z. leptacantha					5	19	18	11	11
Z. perlita			3	18	26	7			
Z. viridiventer	3	24	26	5					

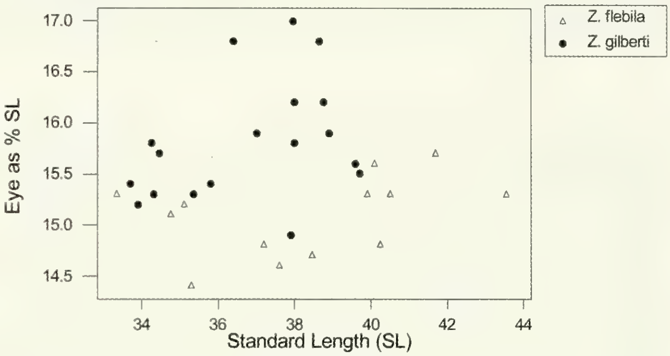

FIGURE 3. Eye diameter as percentage standard length versus standard length. *Zoramia flebia* open triangles, *Z. gilberti* closed circles.

ETYMOLOGY.— The specific epithet is an adjective from the Latin *flebilis* (tearful), referring to the teardrop-shaped marks on the cheek.

COMPARISONS.— *Zoramia flebila* differs from *Z. leptacantha* by lacking the dark line on the dorsum from the origin of the first dorsal fin onto the caudal peduncle. It also has a caudal spot that *Z. leptacantha* lacks. It differs from *Z. perlita* by lacking the dark lines just above the insertion of some of the anal-fin rays. It differs from *Z. gilberti* by lacking either a prominent or diffuse dark spot on the opercular flap, and by having a significantly (T=-4.14, P=0.000, DF=28) smaller eye (Fig. 3). It differs from *Z. fragilis* and *Z. viridiventer* by having diffuse melanophores on the caudal peduncle in addition to a small caudal spot, by usually having scattered melanophores on the breast, pelvic fins, and posterior part of the second dorsal fin that are lacking in *Z. fragilis* and *Z. viridiventer*. It also has a line of dark pigment along the anal-fin base that is lacking in both species. Whereas *Z. fragilis* and *Z. viridiventer* usually have black tips on the caudal fin, there is no such coloration in *Z. flebila*. The body is deeper (39.7–47.2: 44.1 % SL) in *Z. flebila* than in *Z. viridiventer* and *Z. fragilis* (usually less than 40% SL). *Zoramia flebila* differs from all described species by its distinctive coloration. For a comparison of gill-raker counts, see Table 2.

Two DNA tissue samples, 4020 and 4024, are deposited at the University of Kansas. The voucher specimens for these samples are 4024 = CAS 219847, and 4020 = KU 31970.

Zoramia viridiventer Greenfield, Langston and Randall, sp. nov.

Figs. 1E, 4–6; Tables 2–3.

Apogon fragilis (non Smith) Burgess and Axelrod, 1975:1442, lower fig. (Madang, Papua New Guinea).

Apogon gilberti (non Jordan and Seale) Hayashi, 1980:263, fig. 2 (Ishigaki, Okinawa Prefecture).— Hayashi and Kishimoto, 1983: 36, fig. 39 (Iriomote Island).

Apogon fragilis (non Smith) Russell, 1983:49 (One Tree Island, Capricorn Group, southern Great Barrier Reef).— Wass, 1984:13 (American Samoa).— Fraser and Lachner, 1985:43, fig. 1 (Indonesia to Samoa Islands).— Eichler and Myers, 1997:136, lower fig. (Ryukyu Islands, Marshall Islands and southern Great Barrier Reef).— Okamura and Amaoka, 1997:302, lower right fig., 303 (Amami O Shima Islands).— Myers, 1999:130, pl. 53, fig. C (Palau and southern Marshall Islands).

Zoramia fragilis (non Smith) Randall, 2005:215, middle fig. (western Pacific east to Marshall Islands and Samoa).

Material examined.— Holotype: BPBM 32507, 39.2 mm, Papua New Guinea, Madang Province, lagoon side of Pig Island (Tab Island), coral patch in 17 m, rotenone, J.E. Randall and P.L. Colin, 3 November 1987. Paratypes: CAS 222277, 10: 32.5–40.0 mm, Caroline Islands, Pohnpei, Tokoteihi, inner reefs bordering lagoon west of pass, depth to 4.5 m, rotenone, R.R. Rofen et al., 1 July 1954; CAS 222278, 8: 35.0–38.0 mm, Vanuatu, Espiritu Santo, Palikulo Bay, isolated coral head surrounded by sand, 0.5–4 m, rotenone, R.L. Bolin and R. Persson, 7 October 1958; BPBM 8071, 35: 24.5–36.6 mm, Palau, limestone islet southwest of Urukthapel, fringing reef, 9 m, rotenone, J.E. Randall and E.S. Helfman, 11 June 1968; BPBM 9699, 4: 27.0–31.7 mm, Marshall Islands, Majuro Atoll, lagoon, 2 m, quinaldine, J.E. Randall and A.R. Emery, 30 March 1970; AMS I.17086-009, 10: 33.5–38 mm, Papua New Guinea, Madang Harbor, Paeowai Island, 5°11′S, 145°51′E, 9–11 m, B.B. Collette and party, 25 May 1970; BPBM 15627, 11: 31.5–36.2 mm, Solomon Islands, Alite Reef (off Malaita), lagoon coral head, 3 m, rotenone, J.E. Randall and G.R. Allen, 25 July 1973; BPBM 15684, 25.9 mm, Solomon Islands, Guadalcanal, Honiara Yacht Harbor, patch reef on mud bottom, 14 m, rotenone, J.E. Randall and B. Goldman, 2 August 1973; AMS I.18272-002, 45.0 mm, Australia, Great Barrier Reef, Capricorn Group, One Tree Island, lagoon, R.H. Kuiter, 20 September 1974; BPBM 19220, 4: 33.4–41.3 mm, Indonesia, Molucca Islands, Ambon, Ambon Bay, Poka, adjacent to wreck of ship near dock; silty bottom with iron wreckage, 15 m, rotenone, J.E. Randall and G.R. Allen, 16 January 1975; AMS I.20976-008, 10: 34.5–40.0 mm, Australia, Great Barrier Reef, Lizard Island, off Mrs. Watson's Beach, 10–11 m, D.F. Hoese and H.K. Larson, 24 November 1978; AMS I.43600-001, 3: 37.2-38.5 mm, BMNH 2005.5.10.1-3, 3: 39.2–40.0 mm, BPBM 40155, 6: 33.9–42.3 mm, NSMT-P 70846, 3: 37.9–38.5 mm, SAIAB 75547, 3: 37.1–38.3 mm, all with same data as holotype; BPBM 39077, 2: 26.5–31.3 mm, Papua New Guinea, New Britain, Kimbe Bay, reef off Walindi Plantation, drop-off among branches of sponge, 16 m, quinaldine, J.E. Randall and J.L. Earle, 21 August 2002.

Diagnosis.— A species of *Zoramia* with only the following dark markings: a small black spot midposteriorly on caudal peduncle one-half pupil diameter or more in size; a faint broad dusky band on side of snout directly before eye; some specimens with a faint dusky line at base of dorsal fins; tips of one or both caudal lobes often blackish; second dorsal-fin spine 18.9–21.7% SL; second anal-fin spine 13.0–15.9% SL; gill rakers 24–27 (rarely 27).

Description.— Dorsal-fin elements VI-I,9; anal-fin elements II,9; last dorsal-fin and anal-fin rays branched to base; pectoral-fin rays 14, uppermost and lower two or three unbranched; pelvic-fin rays I,5, all branched; principal caudal-fin rays 17, upper and lower unbranched; lateral-line scales to caudal-fin base 24 (plus one smaller pored scale extending onto base of fin); two near-equal scales above lateral line to base of first two dorsal-fin spines, followed by a series of large scales in a single row below remaining spines and second dorsal fin, these scales overlapping all but narrow upper part of scales below; scales below lateral line to origin of anal fin 5; predorsal scales 6; circumpeduncular scales 12; total gill rakers on first gill arch 6 + 26 (6–7 + 24–27), only one with 7 rakers on upper limb (raker at angle included in lower count).

Body depth 2.6 (2.55–3.3) in SL (specimens less than about 34 mm progressively more slender); body very compressed, the width 2.8 (2.65–2.8) in body depth; head length 2.55 (2.4–2.55) in SL; dorsal profile of head straight; snout length 3.9 (3.95–4.2) in head length; orbit diameter 2.65 (2.6–2.8) in head length; bony interorbital width 4.45 (4.1–4.65) in head length; caudal-peduncle depth 2.4 (2.5–2.75) in head length; caudal-peduncle length 1.6 (1.55–1.7) in head length. (See also Table 3 for additional porportional measurements.)

Mouth very oblique, forming an angle of about 50° to horizontal axis of head, the lower jaw strongly projecting; maxilla extending to below center of eye, the upper-jaw length 2.25 (2.2–2.4) in head length; posterior end of maxilla with a distinct angular notch; dentition as in the genus. Tongue narrowly triangular with rounded tip, the upper surface with small papillae. Gill rakers well developed, the longest on lower limb nearly half orbit diameter in length. Anterior nostril a small, short, membranous tube on side of snout, slightly more than half distance from fleshy edge of orbit to median anterior point of upper lip; posterior nostril a narrow elliptical opening at level of upper

edge of pupil, its length about one-fourth pupil diameter.

Suborbital margin smooth, ending below center of eye; preopercular ridge slightly irregular, but without serrae; posterior three-fourths of ventral edge of preopercle and ventral half of posterior edge finely serrate.

Origin of dorsal fin over third to fourth lateral-line scales, the predorsal length 2.4 (2.4–2.5) in SL; first dorsal-fin spine 3.9 (3.45–4.05) in head length; second or third dorsal-fin spines longest, 1.9 (1.85–2.15) in head length; spine of second dorsal fin 2.3 (2.35–2.5) in head length; first dorsal soft ray longest (second ray nearly as long), 1.5 (1.45–1.5) in head length; first anal-fin spine very short, 7.75 (7.1–8.4) in head length; second anal-fin spine 2.8 (2.5–3.0) in head length; first anal soft ray longest (second ray nearly as long), 1.75 (1.45–1.8) in head length; caudal fin 3.1 (2.9–3.1) in SL; caudal concavity 3.05 (3.0–3.15) in head length; pectoral fins 1.5 (1.5–1.6) in head length, the third or fourth rays longest; pelvic fins reaching or extending slightly beyond anus, the first or second soft rays longest, 1.75 (1.65–1.85) in head length.

Color of holotype in alcohol pale yellowish on head and body, a little dusky dorsally on nape, along base of dorsal fins, and dorsally on caudal peduncle; a roundish black spot posteriorly on caudal peduncle slightly more than half pupil diameter in size; scattered melanophores on posterior half of caudal peduncle but

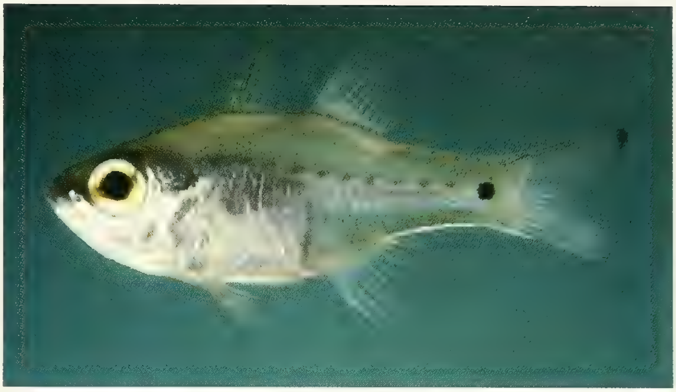

Figure 4. Holotype of *Zoramia viridiventer*, BPBM 32507.

Figure 5. Underwater photograph of *Zoramia viridiventer* taken at site where holotype was captured.

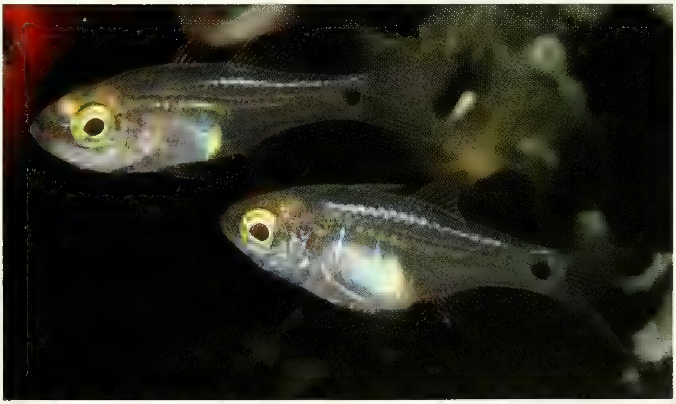

Figure 6. *Zoramia viridiventer* at Karang Elmas Reef, Halmahera.

TABLE 3. Proportional measurements of type specimens of *Zoramia viridiventer* as percentage of the standard length.

	Holotype	Paratypes							
	BPBM 32507	BPBM 39077	BPBM 15627	BPBM 40155	BPBM 40155	BPBM 40155	BPBM 40155	BPBM 40155	BBPM 40155
Standard Length (mm)	39.2	31.3	33.9	35.6	37.5	38.0	39.8	40.4	42.3
Body depth	38.6	35.5	38.2	38.4	37.7	38.7	38.3	39.5	38.6
Body width	13.7	13.4	13.6	13.7	14.6	13.5	14.2	14.1	14.1
Head length	39.5	41.2	41.3	41.7	41.0	41.1	39.1	39.2	40.0
Snout length	10.1	10.2	10.0	10.6	10.3	9.8	9.8	9.9	9.8
Orbit diameter	14.8	16.0	15.5	15.4	15.0	14.6	14.8	14.5	14.2
Interorbital width	8.9	9.2	9.4	9.0	9.1	9.5	9.3	9.6	9.3
Upper-jaw length	17.5	17.5	18.3	17.1	18.6	18.7	17.6`	17.4	17.8
Caudal-peduncle depth	16.4	15.7	15.9	16.1	15.9	15.0	15.7	15.8	15.8
Caudal-peduncle length	25.0	24.4	24.6	24.7	24.5	25.5	25.1	25.1	24.4
Predorsal length	41.5	40.0	41.8	40.7	41.0	41.4	39.9	40.1	39.6
Base of first dorsal fin	14.5	15.0	15.4	14.2	15.2	15.4	15.1	14.8	14.3
First dorsal spine	10.2	11.9	10.3	11.2	10.1	10.7	10.5	broken	10.6
Second dorsal spine	21.0	21.6	19.1	18.9	19.0	18.9	19.1	19.0	21.7
Third dorsal spine	20.8	21.3	21.1	19.3	18.7	18.7	18.8	18.7	21.0
Fourth dorsal spine	16.7	17.2	20.3	16.3	16.0	16.1	15.3	14.1	12.2
Fifth dorsal spine	11.6	12.5	12.7	11.4	11.6	12.1	11.3	13.8	10.9
Sixth dorsal spine	7.7	7.4	broken	6.7	7.8	7.6	7.7	7.2	7.1
Base of second dorsal fin	18.6	18.5	18.0	18.1	18.1	18.2	18.1	18.8	17.9
Spine of second dorsal fin	17.3	17.4	17.7	17.0	16.5	17.4	17.4	16.9	16.3
Longest dorsal ray	26.8	27.2	27.7	27.5	27.8	27.8	26.9	26.9	27.4
Base of anal fin	18.4	19.1	18.6	18.6	18.6	18.1	17.7	18.5	18.0
First anal spine	5.1	4.9	5.7	5.4	5.3	5.0	5.5	5.2	4.8
Second anal spine	14.2	15.9	15.1	14.4	14.0	13.9	15.1	13.0	15.8
Longest anal ray	22.9	27.9	broken	28.3	24.0	24.8	24.9	22.4	22.3
Caudal-fin length	32.3	34.5	broken	33.6	33.3	33.0	33.7	32.1	32.5
Caudal concavity	13.0	13.7	--	13.2	13.2	13.4	12.7	12.6	13.0
Pectoral-fin length	26.4	25.6	26.7	26.9	26.5	26.6	25.2	25.2	26.2
Prepelvic length	38.4	40.9	39.3	38.5	40.5	39.9	40.4	38.4	39.0
Pelvic spine	15 8	15.9	16.9	15.4	15.5	16.6	15.6	14.8	14.6
Pelvic-fin length	22.5	23.9	24.0	22.4	24.3	23.7	23.5	22.2	23.7

far less than the density dorsally on body; a faint broad dusky band on side of snout centered slightly below middle of eye; spines and rays of fins translucent yellowish, only the first two dorsal-fin spines and membranes a little dusky; remaining membranes of fins translucent; tips of caudal-fin lobes blackish (faint on lower lobe); the black digestive tract is visible as a faint dark area of the abdomen, becoming near-black as the intestine nears the anus.

Color of holotype when fresh as in Figure 4. The body other than the abdomen is translucent, making the vertebral column visible, and the small blue spots are apparent on the operculum and upper abdomen.

Figure 5 is from an underwater photo of an individual of this species taken at the collecting site of the holotype. The green area posteriorly on the abdomen often covers more of the abdomen, as may be seen in other underwater photographs such as those cited in the synonymy above.

The two fish of Figure 6 were photographed in 50 m at Karang Elmos Reef, Halmahera (0°10′1″N, 128°7′E); note the two vertical blue lines on the side above the pectoral fin.

Underwater photographs of aggregations of this species may show individuals with or without black tips on the caudal lobes. More often than not, at least the upper lobe shows a blackish distal end. As mentioned above, museum specimens often have abraded fins, especially the caudal, so black tips, had they been present, were lost.

Etymology.— The specific epithet is a compound adjective from the Latin *viridis* for green and *venter* for abdomen, in reference to the green coloration usually present on the abdomen in life, at least in adults.

Comparisons.— *Zoramia viridiventer* differs from *Z. leptacantha* by lacking the dark line on the dorsum from the origin of the first dorsal fin onto the caudal peduncle. It also has a caudal spot that *Z. leptacantha* lacks. It differs from *Z. perlita* by lacking the dark lines just above the insertion of some of the anal-fin rays. It differs from *Z. gilberti* by lacking either a prominent or diffuse dark spot on the opercular flap. It differs from *Z. flebila* by lacking diffuse melanophores on the caudal peduncle in addition to the small caudal spot, and by usually having black tips on the caudal fin. Finally, it differs from *Z. fragilis* by having fewer gill rakers (24–27 verses 27–30), a shorter second dorsal-fin spine (18.9–21.7 verses 21.5–24.8), and a shorter second anal-fin spine (13.0–15.9 verses 15.1–17.9).

Remarks.— We became suspicious that the material reported by Fraser and Lachner (1985) as *Apogon fragilis* Smith, 1961 might contain two species when we noticed the broad gap in the distribution of the species shown in their Figure 20 between the Seychelles and Sulawesi, and the broad range of the gill-raker counts of *A. fragilis* in their Table 4. Loans of paratypes of *A. fragilis* from Mozambique and specimens from Madagascar identified as *A. fragilis* by Fraser and Lachner provided a nearly complete separation of gill-raker counts from Pacific specimens (Table 2). This difference was reinforced by measurements that demonstrate that the second dorsal and anal-fin spines are generally longer in *Z. viridventer* than in *A. fragilis*, as shown in our key.

We are not aware of any color photographs taken of *A. fragilis* when fresh or alive from the two localities for the species given by Smith (1961), Pinda, Mozambique and the Seychelles, or from the Madagascar locality reported by Fraser and Lachner. Smith included a painting of the species by Margaret Smith with his description of the species. It shows a pinkish-gray fish, becoming pale bluish gray on the abdomen, with a small black basicaudal spot, strong black stripe on the side of the snout and tip of lower jaw, a blackish line at base of the dorsal fins and dorsally on the caudal peduncle, black tips on the caudal lobes, and an orange line on the anal fin near the base.

Kuiter (1998:86) identified two underwater photographs from the Maldive Islands as *Apogon gilberti*, but neither is *Zoramia gilberti*. The single fish in the figure to the left could be *Zoramia viridiventer*, but without a specimen for study, we cannot be sure. The two fish in the figure to the right are gray with a broad iridescent blue-green stripe on the body at the level of the upper end of the gill opening, a very small black basicaudal spot, black-tipped caudal lobes, and a tiny black tip on the first dorsal fin. They appear to represent an undescribed species.

The distribution of *Zoramia viridiventer* is largely as given for the Pacific part of Fraser and Lachner's Figure 20 for *Apogon fragilis*: Philippines, Indonesia, Palau, Yap and Kapingamarangi in the Caroline Islands, southern Marshall Islands, northern Kiribati, Papua New Guinea, Great Barrier Reef, Solomon Islands, Vanuatu, and Samoa Islands. They reported the third author and associates' collections from Palau (in 1968), Marshall Islands, Solomon Islands, and Papua New Guinea. Randall et al. (2004) reported *Apogon fragilis* from Tonga, but the identification as *viridiventer* is questionable because of slightly higher gill-raker counts in the limited material available.

Hayashi (1980) placed *Apogon fragilis* in the synonymy of *A. gilberti* (Jordan and Seale), type locality, Negros. He reported *A. gilberti* from Ishigaki in the southern Ryukyu Islands; his black and white figure is not *A. gilberti* but appears to be *A. viridiventer*, in which case it would be the first record of the species from Japanese waters. We conclude the same for Hayashi and Kishimoto (1983) who reported *A. gilberti* from Iriomote Island in the Ryukyus.

Russell (1983) was the first to record this species from Australia (as *Apogon fragilis*). He listed two specimens, AMS I.18267-005 and I.18271-002, from One Tree Island, Capricorn Group,

southern Great Barrier Reef. The former was found at the Australian Museum by Mark A. McGrouther and Sally Reader, who reported it as "dried out beyond retrieval." The latter is a species of *Canthigaster*. The number Russell should have given was AMS I.18272-002, 45 mm SL. It is included above as one of the paratypes of *Zoramia viridiventer*, as is one lot from Lizard Island in the northern Great Barrier Reef.

This species is usually seen in aggregations in lagoons or bays, sheltering among branching corals, sponges, etc. Our collections have come from the depth range of 2–17 m, but as noted above, the species may be seen at least as deep as 50 m.

Acknowledgments

We thank K.R. Longenecker and B.K. Mataitini for assistance in collecting specimens, and Captain B. Vasconcellos and the crew of the *Moku Mokua Hine* for assistance in the field. We are grateful to J. Seeto, G.R. South, R.R. Thaman, and R.W. Tuxton of the University of the South Pacific, Fiji for facilitating our collecting in Fiji. We also thank the Fijian Government and local village chiefs for permission to collect fishes. We thank M. McGrouther and S. Reader of AMS and J.T. Williams of USNM for lending specimens. Special thanks to the staff at CAS for providing assistance: D. Catania, W.N. Eschmeyer, J. Fong, M. Hoang, and T. Iwamoto. The authors also appreciate the helpful comments of the anonymous reviewers. This research was supported by National Science Foundation grants INT97-29666 and DEB0-1027545, and Sea Grant Project R/FM-6PD.

Literature Cited

Bleeker, P. 1856. Achtste Bijdrage tot de Kennis der ichthyologische Fauna van Ternate (1). *Natuurkundig Tijchschrift voor, Nederlandsch-Indië* 12:191–210.

Burgess, W., and H.R. Axelrod. 1975. *Pacific Marine Fishes*. Book 6, Fishes of Melanesia. T.F.H. Publications, Neptune City, New Jersey, USA. Pp. 1383–1654.

Eichler, D., and R.F. Myers. 1997. *Korallenfische Zentraler Indopazific*. Jahr Verlag, Hamburg, Germany. 489 pp.

Fraser, T.H. 1972. Comparative osteology of the shallow water cardinal fishes [Perciformes: Apogonidae] with reference to the systematics and evolution of the family. *Ichthyological Bulletin of the J.L.B. Smith Institute of Ichthyology Rhodes University*, Grahamstown (34):1–105 pp.

Fraser, T.H., and E.A. Lachner. 1985. A revision of the cardinalfish subgenera *Pristiapogon* and *Zoramia* (Genus *Apogon*) of the Indo-Pacific Region (Teleostei: Apogonidae). *Smithsonian Contributions to Zoology* (412):1–47.

Günther, A.C.L.G. 1873. Die fische der Sudsee (I). *Journal des Museum Godeffroy* 1:1–128.

Hayashi, M. 1980. First records of three apogonid fishes from Japan. *Japanese Journal of Ichthyology* 27(3):261–267.

Hayashi, M., and H. Kishimoto. 1983. Fish fauna of Iriomote-Island, Ryukyu Islands. III. Apogonidae (Apogoninae). *Scientific Report of the Yokosuka City Museum* (31):15–46.

Jordan, D.S. 1917. Notes on *Glossamia* and related genera of cardinalfishes. *Copei*a (44):46–47.

Kuiter, R.H. 1998. *Photo Guide to Fishes of the Maldives*. Atoll Editions, Apollo bay, Victoria, Australia. 257 pp.

Myers, R.F. 1999. *Micronesian Reef Fishes*, ed. 3. Coral Graphics, Guam. vi + 330 pp.

Okamura, O., and K. Amaoka. 1997. *Sea Fishes of Japan*. Yama–kei Publisher, Tokyo, Japan. 783 pp. [in Japanese]

Randall, J.E. 2005. *Reef and Shore fishes of the South Pacific, New Caledonia to Tahiti and the Pitcairn Islands*. University of Hawaii Press, Honolulu, Hawaii, USA. 707 pp.

Randall, J.E., D.G. Smith, J.T. Willliams, M. Kulbicki, G. Mou Tham, P. Labrosse, M. Kronen, E. Clua,

AND B.S. MANN. 2004. Checklist of the shore and epipelagic fishes of Tonga. *Atoll Research Bulletin*, no. 502. 35 pp.

RODMAN-BERGMAN, L.M. 2004. *The Cephalic Lateralis System of Cardinalfishes* (*Perciformes: Apogonidae*) *and its Application to the Taxonomy and Systematics of the Family*. Ph.D. dissertation. University of Hawaii, Honolulu, Hawaii, USA. 373 pp.

RUSSELL, B.C. 1983. *Annotated Checklist of the Coral Reef Fishes in the Capricorn-Bunker Group, Great Barrier Reef, Australia*. Great Barrier Reef Marine Park Authority, Special Publication Series 1. 184 pp.

SMITH, J.L.B. 1961. Fishes of the family Apogonidae of the Western Indian Ocean and the Red Sea. *Ichthyological Bulletin, Rhodes University* (22):370–418.

WASS, R.C. 1984. An annotated checklist of the fishes of Samoa. *NOAA Technical Report NMFS SSRF781*: 1–43.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 34, pp. 639–655, 5 pls. December 30, 2005

Scanning Electron Microscope Studies of Some Early Miocene Diatoms from the Equatorial Pacific Ocean with Descriptions of Two New Species, *Actinocyclus jouseae* Barron and *Actinocyclus nigriniae* Barron

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Scanning electron microscope (SEM) and light microscope (LM) studies are used to propose and describe two new species, *Actinocyclus jouseae* Barron, sp. nov. and *Actinocyclus nigriniae* Barron, sp. nov. from lower Miocene sediments from equatorial Pacific ODP Site 1219. Parallel SEM and LM studies reveal that *Thalassiosira bukryi Barron* should be transferred to *Azpeitia* and suggest that *Actinocyclus barronii* Radionova is likely to be a variety of *A. radionovae* Barron

During the study of the biostratigraphy of diatoms from lower Miocene (24–17 Ma) sediments of equatorial Pacific ODP Site 1219 (7°48.019′N, 142°00.940′W; 5063 m water depth) (Barron, in press), two species of *Actinocyclus* were observed that were not described by either Barron (1983) or Radionova (1991). Description of these new taxa and clarification of the taxonomic relationships of three other early Miocene diatoms from ODP 1219 warrants detailed study under LM and SEM. The purpose of this paper is to detail the valve ultrastructure of these fossil taxa and resolve their taxonomic position.

Methods and Materials

For the biostratigraphic study of Barron (in press), Cores 4H through 6H (*ca.* 24.5 to 17.0 Ma) of ODP Hole 199-1219A were sampled at 50 cm intervals, with occasional samples taken at 30 cm intervals. Approximately 1 g of material was placed in a 250 ml beaker, disaggregated with a wooden stirring rod, and covered with distilled water. Dilute (*ca.* 3%) hydrochloric acid was then added to remove the calcium carbonate. After the reaction ceased, the sample was washed with distilled water and centrifuged at 1200 rpm for 4 minutes duration in order to bring the solution to a neutral pH. After completion of the washing process, strewn slides were prepared by transferring the suspended material with a disposable pipette to a 22 × 40 mm coverslip, which was then dried on a hot plate and mounted with Naphrax on a 25 × 75 mm glass slide.

These slides were examined in their entirety under a light microscope (Leitz Ortholux) at magnification ×500, with identifications checked at ×1250. The LM photography was completed using a Spot Insight v. 4.0 digital camera on a Leica DML microscope. SEM studies were completed on selected samples with a Leo 1450VP microscope.

Descriptions of New Species

Actinocyclus jouseae Barron, sp. nov.

Plate 1, figs. 1, 4, 5; Plate 2, figs. 1, 2.

Nomenclatural synonym: *Actinocyclus challengeri* Jousé in Jousé, (ed.), 1977, pl. 57, figs. 10, 24–25, 36, nom invalid (no description). This name is a later homonym of *A. challengeri* O'Meara, 1876.

Description.— Diameter 33 to 95 µm. Linear rays of areolae increasing in size from 8–9 in 10 µm near the center to about 5 in 10 µm near the margin. Typically each primary (or sub-primary) ray is joined by one secondary ray. High (4–5 µm high) mantle near margin covered by dense areolae, about 8–10 in 10 µm. Prominent pseudonodule (circular, about 0.7 µm in diameter) located at crest of margin. Valve surface undulated, with a raised marginal region, which occupies about one third of the valves diameter. This is followed inward by an abrupt depression and a gentle rise to the valve's center. Primary radial areolar rays extend from the valve's center to the raised marginal region. These are separated by three shorter, secondary areolar rays.

Comments.— *Actinocyclus jouseae* resembles the early middle Miocene diatom, *A. ingens* var. *nodus* Baldauf in Baldauf and Barron (1980) in that the valve is undulated with a raised center and it possesses a dense radial, linear pattern of areolae. Whereas the areolae of *A. jouseae* increase in size from 8 to 9 in 10 µm near the center to about 5 in 10 µm near the margin, the areolae of *A. ingens* var. *nodus* decrease in size toward the margin (5 areolae in 10 µm near the center to 9 areolae in 10 µm near the margin). This character gives the areolar pattern of *A. jouseae* a finer, denser appearance than that of *A. ingens* var. *nodus*.

Derivation of name.— In honor of Anastasia P. Jousé, diatomist and pioneer diatom stratigrapher.

Material examined.— Holotype: CAS accession number 625066, CAS slide number 221091, ODP 1219A-4H-4. 58–59 cm (Plate 1, figure 1), Deposited at the California Academy of Sciences, San Francisco; Paratypes: CAS slide number 221090, ODP 1219A-4H-4, 8–9 cm (Plate 1, figure 4); CAS slide number 221092, ODP 1219A-4H-5, 8–9 cm (Plate 1, figure 5).

Stratigraphic range.— early Miocene (20.0–19.1 Ma) (Barron, in press).

Actinocyclus nigriniae Barron, sp. nov.

Plate 1, figs. 2, 3, 6, 7; Plate 2, figs. 3. 4.

Nomenclatural synonyms: *Cestodiscus* sp. 6 of Schrader, 1976, pl. 12, fig. 4.; *Cestodiscus kugleri* sensu Fourtanier, 1991, pl. 1, fig. 5.

Description.— Diameter 15 to 70 µm. Number of rays: three to four rudimentary rays in small specimens to 15 in larger specimens. Areolae decrease slightly in size from 8 in 10 µm near valve center to 11–12 in 10 µm near margin. Steep mantle, densely areolated 11–12 areolae in 10 µm. Prominent rounded pseudonodule located near crest of submarginal ring. Valves dimorphic, convex and concave, larger specimens tend to be flatter; smaller specimens tend to be domed. Distinctive "star-like" hyaline rays, which consist of a primary areolar row beginning near the center of the valve, and three to four additional rays of areolae on either side of the primary row, beginning at regular distances toward the margin. Note: Similar to *Cestodiscus praerapax* Radionova, 1991, pl. IV, figs. 1, 12; however, it lacks stripes on margin (N. Radionova, 2005, written commun.)

Comments.— *Actinocyclus nigriniae* resembles *Cestodiscus kugleri* Lohman 1974; however, its radial hyaline rays are less step-like in appearance and its valves possess a prominent pseudonodule on their raised, submarginal ring. *Actinocyclus nigriniae* is also similar to *Cestodiscus praer-*

apax Radionova, 1991, pl. IV, figs. 1, 12; however, it lacks stripes on margin (N. Radionova, 2005, written commun.)

Derivation of name.— In honor of Cathy Nigrini, radiolarian biostratigrapher.

Material examined.— Holotype: CAS accession number 625068, CAS slide number 221093, ODP 1219A-5H-6, 110–111 cm (Plate 1, figure 6). Deposited at the California Academy of Sciences, San Francisco. Isotypes: CAS slide number 221093, ODP 1219A-5H-6, 110–111 cm (Plate 1, figure 2); CAS slide number 221093, ODP 1219A-5H-6, 110–111 cm (Plate 1, figure 3); CAS slide number 221093, ODP 1219A-5H-6, 110–111 cm (Plate 1, figure 7).

Stratigraphic range.— early Miocene (22.7–22.3 Ma) (Barron, in press).

New Combination

***Azpeitia bukryi* (Barron) Barron, n. comb.**

Plate 3, figs. 1–5; Plate 4, figs. 1–5.

Basionym: *Thalassiosira bukryi* Barron, 1983:511, plate IV, fig. 1.

Original description.— "Flat, round valve 20 to 60 µm in diameter. Hexagonal areolae (about 7 in 10 µm) arranged in a sublinear to eccentric pattern in the central ¾s of the valve with 2 to 4 marginal eccentric rows of progressively smaller areolae (9 to 12 in 10 µm). Areolae pattern resembles that of *Thalassiosira oestrupii* (Ostenfeld) Proshkina-Lavrenko. A small hyaline central area about 1–2 µm in diameter is often present, especially in larger forms, commonly containing a rounded central nodule. Numerous small pores dispersed over the valve face separated by 3 to 4 of the larger areolae. Marginal apiculi separated by 7 small areoale. Thin striated margin (1 um in width) with 10 radial striae in 10 µm."

Holotype.— USNM 348710, Plate IV, fig. 1, sample DSDP 77B-28-6, 28–30 cm

Emended description.— *Azpeitia bukryi* (Barron) Barron possesses a ring of weakly stalked, rimoportulae opening on the valve/mantle interface (Plate 4, figures 1, 3) that are all similar in appearance (Plate 4, figure 3). Although no distinct annulus is present (Plate 3, figures 3–5), larger valves commonly possess a slightly off-center central process (rimoportulae) that is surrounded by a hyaline area (compare Plate 3, figures 1–3). When viewed under the SEM (Plate 3, figures 3–5), the eroded remains of this central rimoportulae shows little or no external projection (Plate 3, figure 5) in a manner similar to that of *Azpeitia tabularis* (see Figure XIV, 1B of Fryxell et al., 1986). Numerous interlocular pores appear on the valve's surface (Plate 3, figures 1–5; Plate 4, figure 4) that are assumed to be rimoportulae. The internal openings of these rimoportulae, however, are eroded in the specimens examined so far under the SEM and are not diagnostic (Plate 4, figure 5). Because satellite pores of strutted processes are normally preserved in fossil material even when the tubes of strutted processes have been eroded (Hasle, 1985), it is assumed that these processes are labiate processes.

Areola are loculate with external cribra lying slightly below the valve surface (Plate 4, figures 2, 4), arguing against placement in *Thalassiosira*. Elongated areolae separate the tube-like chambers of the marginal rimoportulae (Plate 3, figures 3–4; Plate 4, figure 3). This distinctive marginal structure gives the appearance of being striae in LM (Plate 3, figures 1–2). Girdle bands have not yet been observed in the fossil material of *A. bukryi*.

Comments.— *Azpeitia* is "characterized by valves with a nearly central labiate process often on the edge of an annulus, a ring of labiate processes on the valve mantle, specialized areolar patterns of the mantle differing from those on the face of the valve, and two or more (usually three) hyaline girdle bands including a wide valvocopula" (Fryxell et al. 1986).

The regular ring of marginal rimoportulae, the shallow mantle with a valve structure differing from that of the valve face, the loculate areolae with external cribra all support transfer of *T. bukryi* to *Azpeitia*. Similarly, like many species of *Azpeitia*, *T. bukryi* seems to have preferred warmer waters during its early Oligocene to early Miocene range (Barron et al. 2004).

The marginal rimoportulae, structure of the shallow mantle and presence of numerous, scattered rimoportulae on the valve surface closely resemble those of *Azpeitia biannulata* Sims in Mahood et al. (1993), which was described from the lower Oligocene of Prydz Bay, Antarctica.

Stratigraphic range.— early Oligocene to early Miocene (33.1–17.5 Ma) (Barron et al. 2004; Barron, in press).

Comparison of *Actinocyclus barronii* Radionova and *A. radionovae* Barron

Radionova (1985, 1987, 1991) studied early Miocene diatoms from DSDP Sites 63, 65, 66, 166, 289, 574, 575, providing SEM illustrations of many taxa and describing five new species, *Actinocyclus barronii*, *A. mutabilis*, *A. praellipiticus*, *Cestodiscus umbonatus*, and *C. praerapax*. Although her species *A. barronii* closely resembles *A. radionovae* Barron 1983, Radionova (1991) stated that it differed from *A. radionovae* by its having (1) a considerably smaller undulation of the valve, (2) the absence of shortened lines of areolae, (3) the presence of hyaline ribs surrounding the central hyaline field. During the study of the early Miocene diatoms of ODP 1219A, it became clear that further taxonomic study was necessary to distinguish the two species of *Actinocyclus*.

Actinocyclus barronii Radionova, 1985

Actinocyclus barronii Radionova, 1985:72, pl. 1, fig. 1; Radionova, 1991:65, pl. V, figs. 2, 4.

Description (taken from Radionova [1991] because an English translation for that paper was available).— "Valve round, sometimes oval, 60–100 µm, slightly concave. Central part of valve (⅓ of its diameter) occupied by a flat hyaline field. This field has a polyangle as star-shaped and connects with the rest of the valve by hyaline ridges, which continue in the line of areolae and reach to the margin of the valve. Pseudonodule large, without operculum. On the mantle of the valve occur 8–10 rimoportulae, which on the external surface are ended by a side aperture, which is a little smaller than the psuedonodule. Mantle is short (low), margin with rough striae."

Comments.— Extensive examination of Site 1219 material reveals that specimens assignable to *A. barronii* possess shortened lines of areolae (Plate 5, fig. 2) and appear to only differ from the considerable variation in the morphology of *A. radionovae* (Plate 5, figs. 1, 2–6) by the much-reduced undulation of their valves. It is not clear what Radionova (1991) means by hyaline ribs surrounding the central hyaline field (compare Plate 5, figs. 1–2, 5). Given also that the range of specimens assignable to *A. barronii* falls completely within the range of *A. radionovae*, it would appear that *A. barronii* represents a variety of *A. radionovae*. This hypothesis would have to be confirmed by an examination of Radionova's (1985) type material of *A. barronii*.

Stratigraphic range.— early Miocene (19.9–19.1 Ma) (Barron, in press).

Actinocyclus radionovae Barron, 1983

Actinocyclus radionovae Barron, 1983:504, pl. III, figs. 1–3; pl. IV, figs. 4–6; Barron, 1985, pl. 1, fig. 2; Radionova, 1991:65, pl. V, fig. 1.

Description (Barron, 1983).— "circular valve with undulating surface 40 to 100 µm in diameter. Hyaline central area 10 to 25 µm in diameter with primary and secondary rows begin-

ning at different distances from the valve's center, giving a 'star burst' appearance. Submarginal area with eroded labiate processes similar to those of Cestodiscus arranged radially every 7 to 10 μm. Margin 2 μm wide with 9 to 13 striae every 10 μm. Prominent rounded luminate pseudonodule located near the margin."

Comments.— In the present study considerable variation has been observed in forms assigned to *A. radionovae*. Both concave valves with hyaline centers (the type concept) and convex valves with centers filled by continuation of the areolar rays appear to occur, especially amongst smaller (<50 μm diameter) forms (Plate 5, figures 1, 3–6).

Stratigraphic range.— early Miocene (22.0–19.1 Ma) (Barron, in press).

Acknowledgments

Robert Oscarson, USGS, provided invaluable assistance with the SEM. This manuscript benefited from the comments of Nora Radionova and the critical reviews of Mary McGann and Scott Starratt. I am also grateful to Ms. Pat Sims of the British Museum for her very helpful comments on the transfer of *Thalassiosira bukryi* to *Azpeitia*. An anonymous reviewer also offered helpful comments.

Literature Cited

Baldauf, J.G., and J. A. Barron. 1980. *Actinocyclus ingens* var. *nodus*: a new stratigraphically useful diatom of the circum-North Pacific. *Micropaleontology* 26:103–110.

Barron, J.A. 1983. Latest Oligocene through early middle Miocene diatom biostratigraphy of the eastern tropical Pacific. *Marine Micropaleontology* 7:487–515.

Barron, J.A. 1985. Late Eocene to Holocene diatom biostratigraphy of the equatorial Pacific Ocean, Deep Sea Drilling Project Leg 85. *Initial Reports of the Deep Sea Drilling Project* 85:413–456.

Barron, J.A. (In press.) Diatom biochronology for the early Miocene of the equatorial Pacific. *Stratigraphy*.

Barron, J.A., E. Fourtanier, and S.M. Bohaty. 2004. Oligocene and Earliest Miocene Diatom Biostratigraphy of Site 1220, ODP Leg 199, Equatorial Pacific. Proceedings of the Ocean Drilling Program, Scientific Results 199(204):1–25. (*<http://www-odp.tamu.edu/publications/199_SR/204/204.htm>*)

Fourtanier, E. 1991. Diatom biostratigraphy of equatorial Indian Ocean Site 758, ODP Leg 121. *Proceedings of the Ocean Drilling Program, Scientific Results* 121:189–208.

Fryxell, G.A., P.A. Sims, and T.P. Watkins. 1986. *Azpeitia* (Bacillariophyceae). Related genera and promorphology. *Systematic Botany Monograph* 13:1–74.

Hasle, G.R. 1985. The fossil diatom *Thalassiosira ornica*, n. sp., *Micropaleontology* 31:280–284.

Hasle, G.R., and P.A. Sims. 1986. The diatom genus *Coscinodiscus* Ehrenb. *C. argus* Ehrenb. and *C. radiatus* Ehrenb. *Botanica Marina* 29:305–318.

Jousé, A.P., editor-in-chief. 1977. *Atlas of Microorganisms, Bottom Sediments of the Oceans* (*Diatoms, Radiolarians, Silicoflagellates, Coccoliths*). Nauka, Moscow, USSR. 196 pp.

Lohman, K.E. 1974. Lower middle Miocene marine diatoms from Trinidad. *Verhandlungen der Naturforschenden Gesellschaft im Basel* 84:326–360.

Mahood, A.D., J.A. Barron, and P.A. Sims. 1993. A study of unusual, well preserved Oligocene diatoms from Antarctica. *Nova Hedwigia Beihefte* 106:243–267.

O'Meara, E. 1876. Report on the Irish Diatomaceae. *Proceedings of the Royal Irish Academy* 2:235–425.

Radionova, E.P. 1985. Lower Miocene diatoms of the tropical zone from the western part of the Pacific Ocean. *Izvestia Geological Sciences* 7:62–74. Nauka, Moscow, USSR. [in Russian]

Radionova, E.P. 1987. Diatom morphology of genus *Cestodiscus* from lower middle Miocene depositions of the tropical zone of the Pacific Ocean. *Methods of Zonal Stratigraphic Work-up According to Microorganisms. Micropaleontology Edition* 29:141–154. Nauka, Moscow, USSR. [in Russian]

Radionova, E.P. 1991. Stratigraphy of Neogene sediments in a tropical area of the Pacific Ocean based on diatoms. *Academy of Sciences of the USSR, Transactions* 456:1–107. Nauka, Moscow, USSR. [in Russian]

SCHRADER, H.-J. 1976. Cenozoic planktonic diatom biostratigraphy of the southern Pacific Ocean. *Initial Reports of the Deep Sea Drilling Project* 35:605–671.

SIMS, P.A., G.A. FRYXELL, AND J.G. BALDAUF. 1989. Crucial examination of the diatom genus *Azpeitia*: Species useful as stratigraphic markers for the Oligocene and Miocene Epochs. *Micropaleontology* 35(4):293–307.

Plates

Plate 1

1 *Actinocyclus jouseae* Barron n. sp. Holotype, CAS slide number 221091, pseudonodule at 5 o'clock, ODP 1219A-4H-4. 58–59 cm.

2, 3 *Actinocyclus nigriniae* Barron n. sp., Isotypes, CAS slide number 221093, pseudonodules at 10 o'clock and 1 o'clock, ODP 1219A-5H-6, 110–111 cm.

4a,4b *Actinocyclus jouseae* Barron n. sp., Paratype, CAS slide number 221090, low and high focus, pseudonodule just below 3 o'clock, ODP 1219A-4H-4, 8–9 cm.

5 *Actinocyclus jouseae* Barron n. sp., Paratype, CAS slide number 221092, larger form with more complex rays, pseudonodule at 9 o'clock, ODP 1219A-4H-5, 8–9 cm.

6 *Actinocyclus nigriniae* Barron n. sp., Holotype, CAS slide number 221093, pseudonodule at 1 o'clock, ODP 1219A-5H-6, 110–111 cm.

7 *Actinocyclus nigriniae* Barron n. sp., Isotype, CAS slide number 221093, pseudonodule at 2 o'clock, ODP 1219A-5H-6, 110–111 cm.

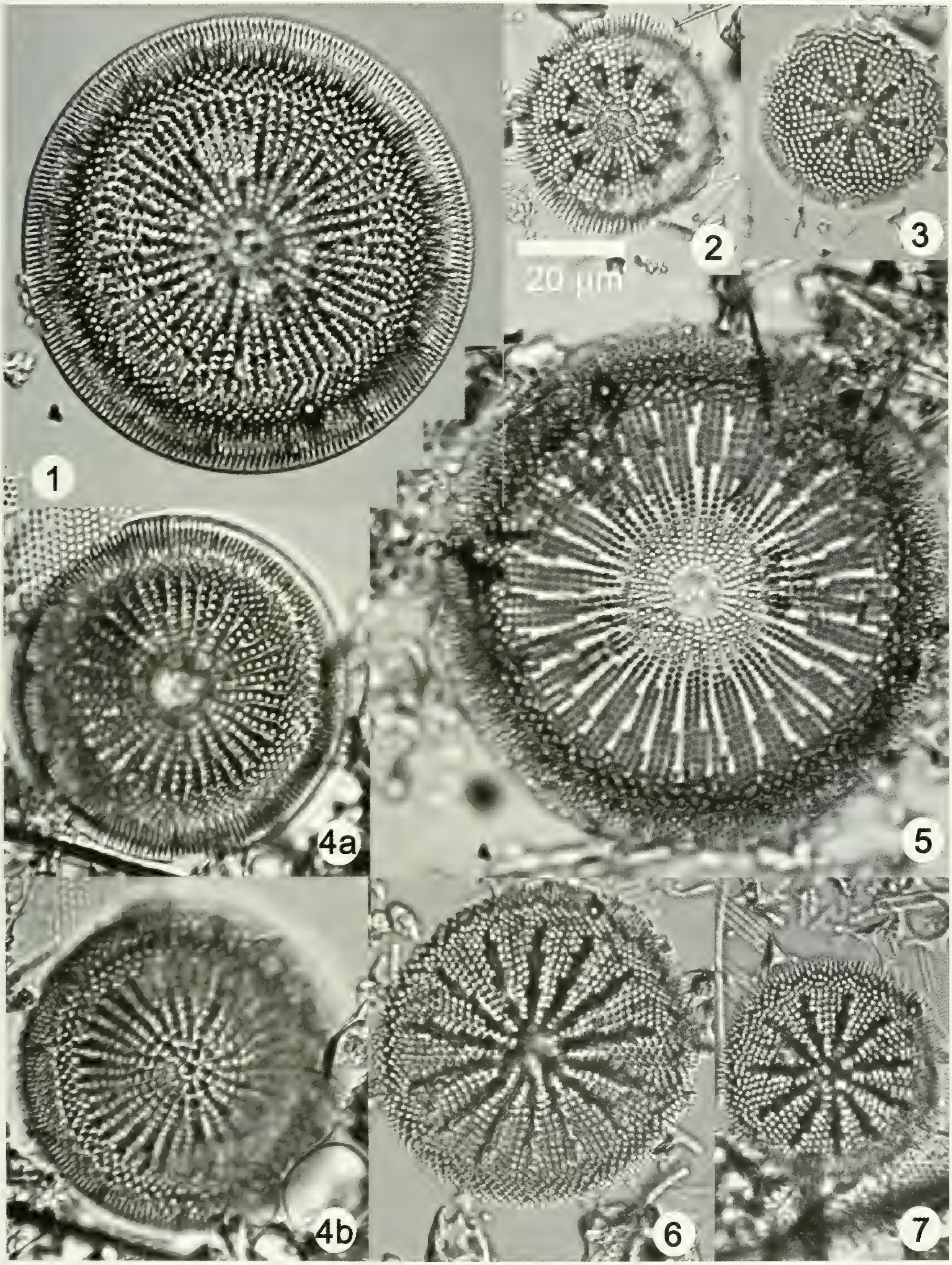

1
2
20 µm
3
4a
5
4b
6
7

Plate 2

Scale bars for Figs. 1, 2a, 3a, 4a = 20 µm; for Figs. 2b, 3b, 4b = 5 µm.

1 *Actinocyclus jouseae* Barron n. sp., external view of valve, Isotype CAS accession number 625066, ODP 1219A-4H-4, 58–59 cm.

2a *Actinocyclus jouseae* Barron n. sp., internal view of valve, Isotype CAS accession number 625066, ODP 1219A-4H-4, 58–59 cm.

2b Close-up of Fig. 2a showing pseudonodule and eroded labiate processes on steep mantle.

3a *Actinocyclus nigriniae* Barron n. sp., external view of valve with concave center, Isotype, CAS accession number 625068, ODP 1219A-5H-6, 110–111 cm.

3b Close-up of margin of Fig. 3a showing pseudonodule.

4a *Actinocyclus nigriniae* Barron n. sp., internal view of valve, Isotype, CAS accession number 625068, ODP 1219A-5H-6, 110–111 cm.

4b Close-up of internal opening of pseudonodule of Fig. 4a.

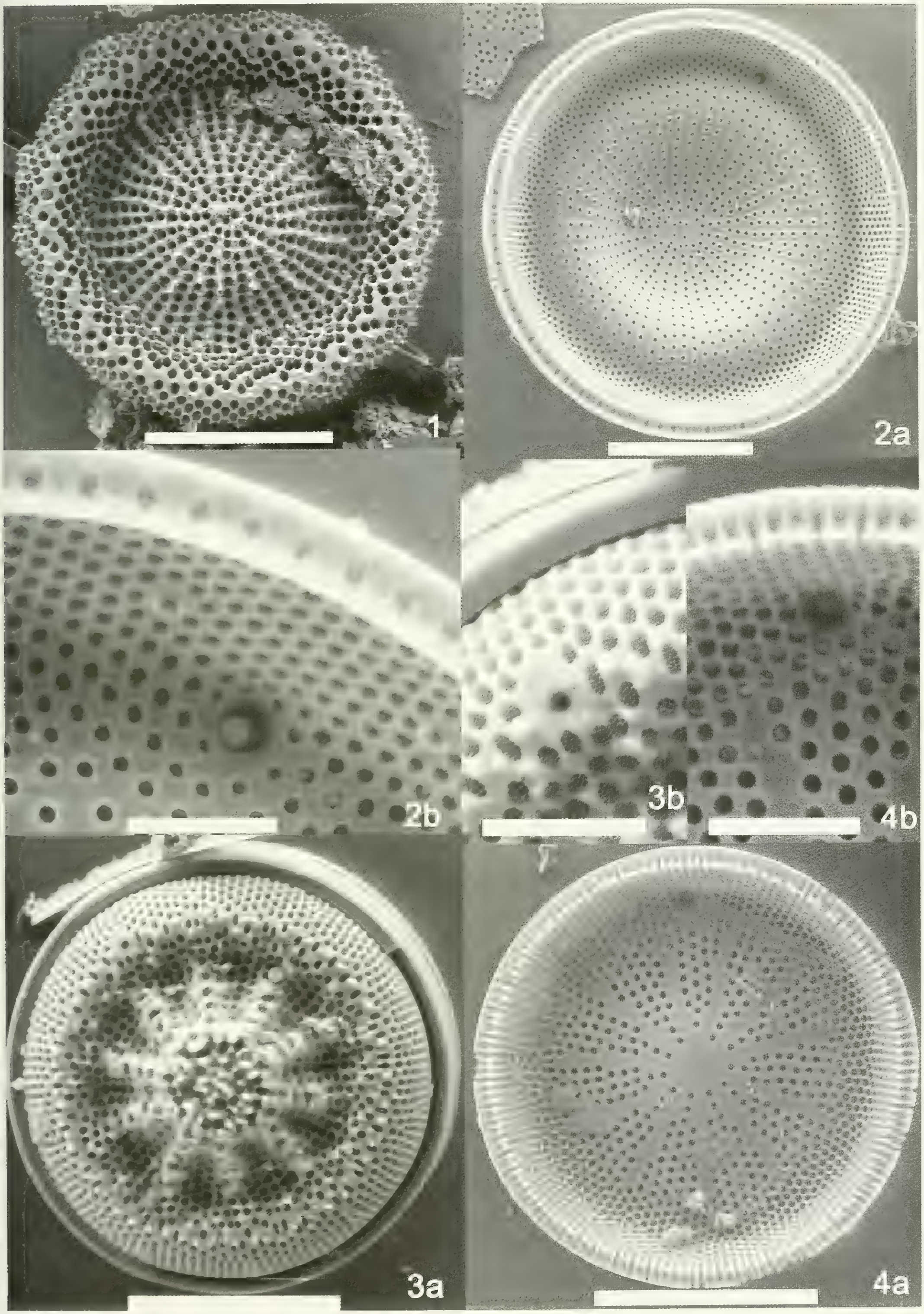

1
2a
2b
3b
4b
3a
4a

Plate 3

Azpeitia bukryi (Barron) Barron n. comb., LM and SEM photos.
1, 2 LM views of valve, ODP 1219A-6H-1, 108–109 cm, scale bar = 20 µm.
3 SEM, External view of valve ODP 1219A-5H-1, 108–109 cm.
4 SEM, External view of valve, showing possible eroded central process, ODP 1219A-4H-4, 58–59 cm.
5 Detail of fig. 4 (enlarged 3X).

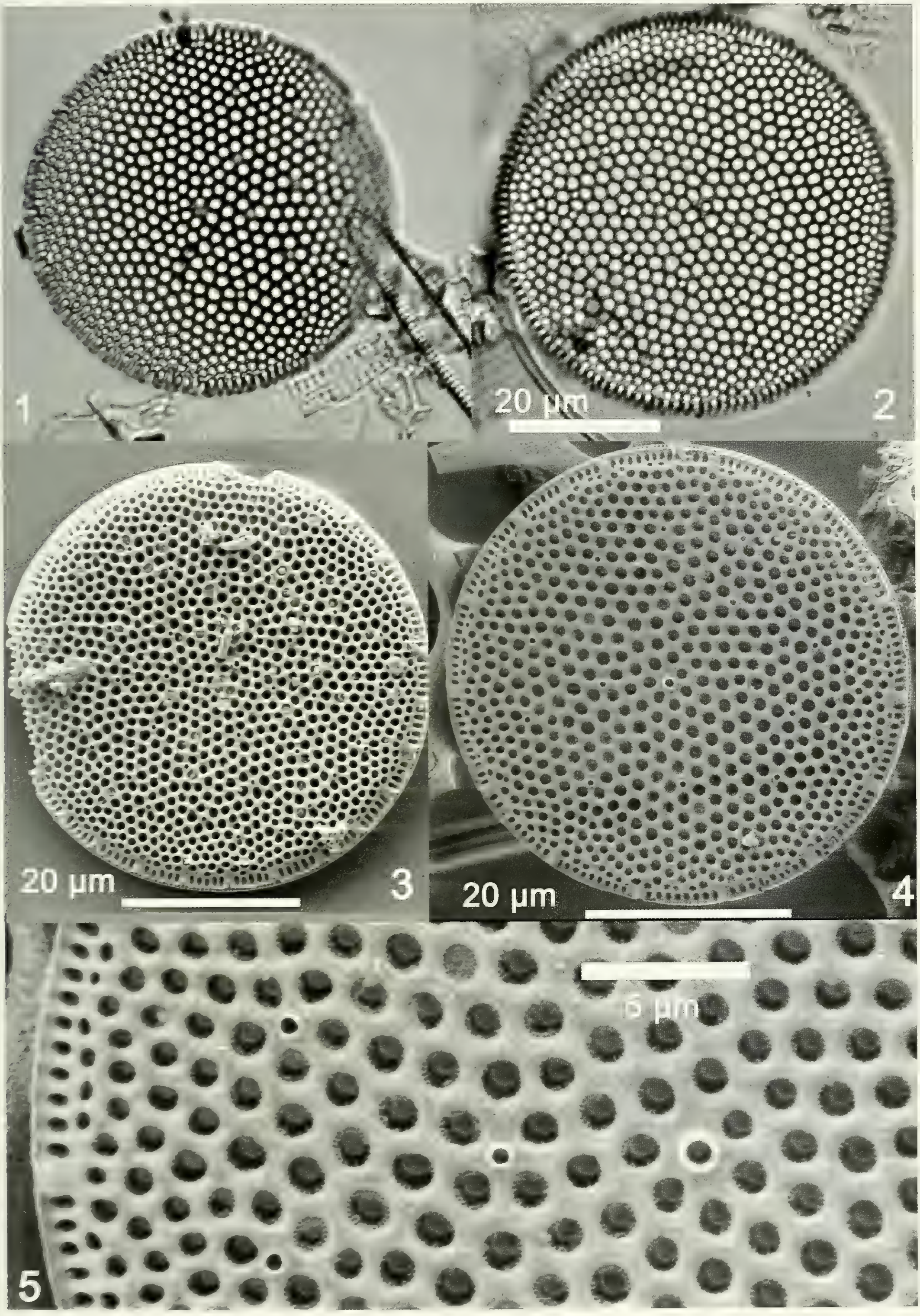

1
20 µm
2
20 µm
3
20 µm
4
6 µm
5

Plate 4

Azpeitia bukryi (Barron) Barron n. comb., SEM photos.
1 Internal view of eroded marginal labiate processes, ODP 1219A-5H-1, 108–109 cm.
2 Detail of margin, ODP 1219A-5H-1, 108–109 cm.
3 Internal view of eroded valve, ODP 1219A-4H-4, 58–59 cm.
4 Detail of cribra and small openings, ODP 1219A-5H-1, 108–109 cm.
5 Detail of Fig. 3 (enlarged 2X).

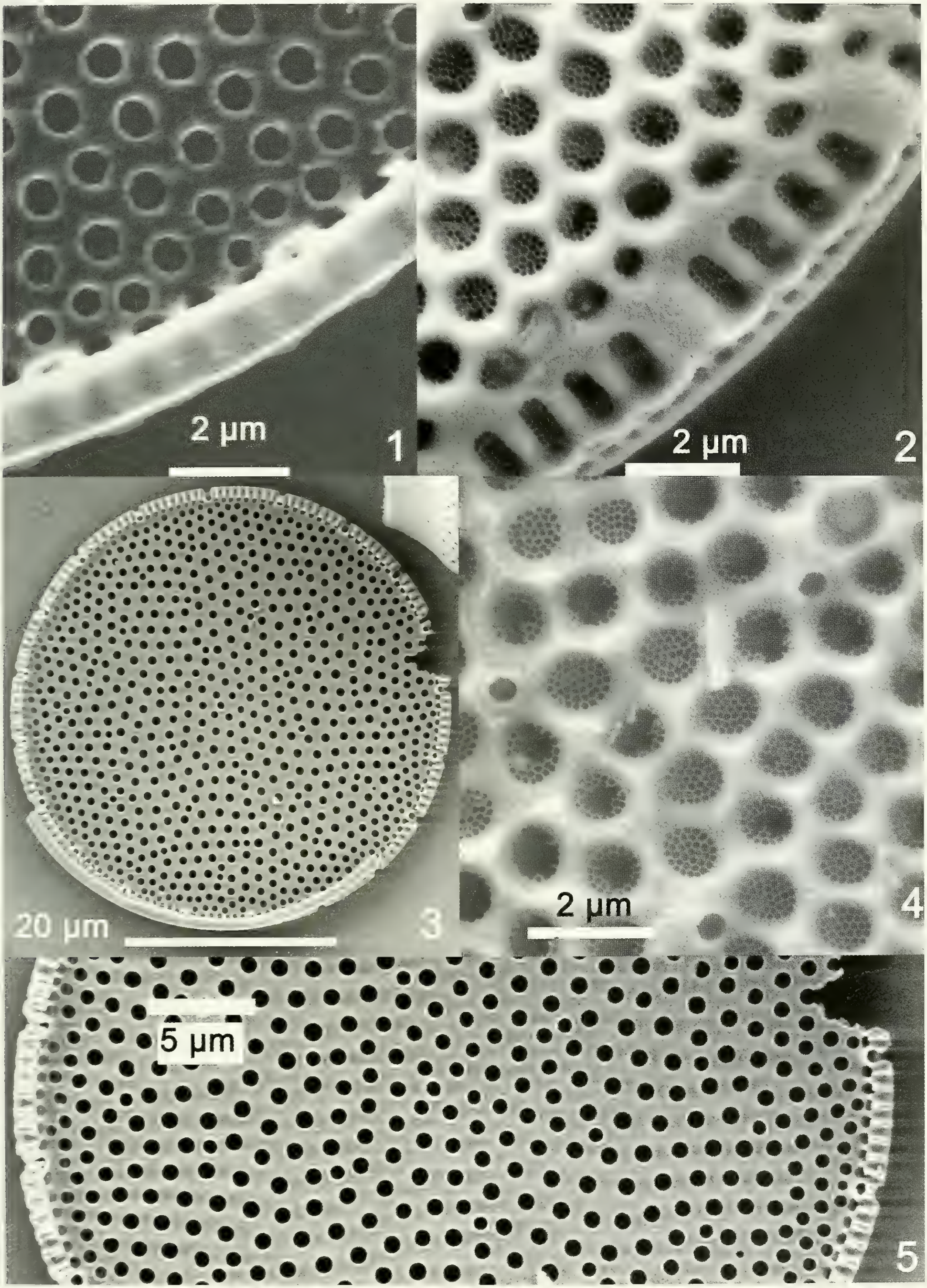

2 μm
1
2 μm
2
20 μm
3
2 μm
4
5 μm
5

Plate 5

Scale bars for all figs. = 20 µm

1 *Actinocyclus radionovae* Barron, external SEM, ODP 1219A-4H-4, 58–59 cm.

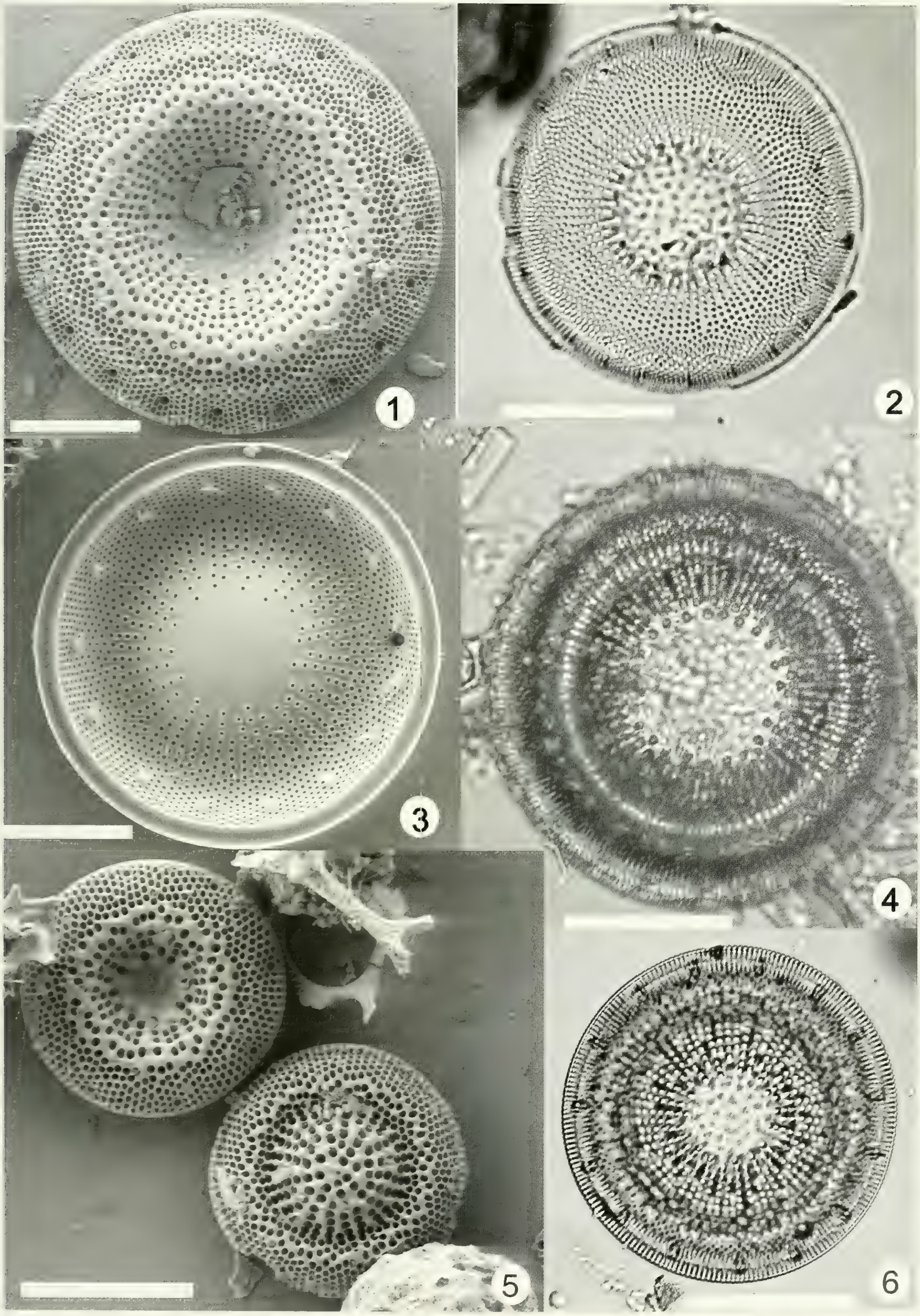
2 *Actinocyclus barronii* Radionova, external LM, pseudonodule at 1 o'clock, ODP 1219A-4H-4, 58–59 cm.

3 *Actinocyclus radionovae* Barron, internal SEM, showing mushroom-shaped labiate processes, and internal opening of pseudonodule at 3 o'clock, ODP 1219A-4H-4, 58–59 cm.

4 *Actinocyclus radionovae* Barron, Holotype of Barron, 1983, USNM 348702, DSDP 495-33-5, 72–76 cm.

5 Concave and convex specimens of *A. radionovae*. s.l. ODP 1219A-4H-4, 58–59 cm.

6 *Actinocyclus radionovae* Barron, pseudonodule at 5 o'clock, ODP 1219A-4H-4, 58–59 cm.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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 35, pp. 657–667, 17 figs., 4 tables. December 30, 2005

A New Species of *Discothyrea* Roger from Mauritius and a New Species of *Proceratium* Roger from Madagascar (Hymenoptera: Formicidae)

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The worker of *Discothyrea berlita* sp. nov. from Mauritius is described. This is the first record of the genus from Mauritius. *D. berlita* is known from a single locality, Le Pouce, a small sanctuary of native ants on an island overrun with invasive ant species. *Proceratium avium* is recollected at Le Pouce and is the senior synonym of *Proceratium avioide* de Andrade (syn. nov.). The practice of manually removing alien plants from native forest plots in Mauritius is not advised for the Le Pouce forest patch because this practice facilitates the establishment of invasive ants, which eliminate native ants. *Proceratium google* sp. nov. is described from Madagascar.

KEYWORDS: Conservation, *Discothyrea*, Formicinae, Hymenoptera, Invasive, Madagascar, Mauritius, *Proceratium*.

In May 2005, I joined a team of Malagasy ant specialists on an expedition to the island of Mauritius, where we conducted an ant inventory and a search for indigenous species. The status of the remaining native species of Mauritius was called into question by P.S. Ward (1990). In inspired literary prose, he described, as W.L. Brown (1974) did earlier, the alarming difficulty of finding native species. Habitat destruction and introduced ants and plants dominate the landscape, pushing native ants up to and possibly over the brink of extinction.

Mauritius has had a long history of exploitation, habitat modification and extinction. With the extinction of the dodo in 1681, 80 years after humans first arrived on Mauritius, colonizers continued to modify habitat at an alarming rate (Lorence and Sussman 1986). The dense Mauritian forests were converted into tea and sugar plantations in the 19^{th} century. During this time, habitat modification on Mauritius reached to almost every corner of the island (Safford 1997). Mauritius is an instructive example of what could happen to other insular environments, such as Madagascar, if habitat destruction is left unchecked. On Mauritius, as on Madagascar, invasive plant and animal species pose major problems. Once established, many invasive ants in Mauritius may be virtually impossible to eradicate, thus preventing the return of native ants (Holway et al. 2002).

The known native ant fauna of Mauritius includes 18 valid species, with 9 endemic to the island (Table 1). It is interesting that the endemic ants are all confined to upland forest. One could conclude that Mauritius has few endemics all of which are on mountaintops. On the other hand, these endemics could be the only remaining examples of a much richer endemic fauna that disappeared with the destruction of the lowland forest. The discovery of a new genus record on Le Pouce, suggests that there are more species to discover on the island and that Le Pouce is a surprising sanctuary of taxonomically peculiar endemic ants.

The site encompasses a rugged and spectacular mountain chain above the industrial city of Port Louis in north-west Mauritius. The main ridge runs approximately east to west, and three long spurs extend northward. Major peaks include Pieter Both (823 m), Le Pouce (812 m) and Montagne Ory (c.700 m). Le Pouce captures moisture from the prevailing wind and clouds, resulting in the presence of native cloud-forest there. This is the only remaining area of native vegetation, although native plants are scattered throughout the range. Exotic vegetation dominates, most notably a scrub of strawberry guava (*Psidium cattleianum*) and privet (*Ligustrum robustrum*) — but grassland and *Eucalyptus* plantations also occur. The best native forest found during our trip, and also the place of greatest number of endemic ants, was a small patch of forest, less than one hectare in area, just at the southeast face of the peak. Based on our survey results across the island, this forest patch on Le Pouce is the only remaining forest refuge for these mountain endemics of Mauritius and should receive high conservation priority.

TABLE 1 List of valid names for native ants recorded from the island of Mauritius. Native ants restricted to Rodrigues (*Monomorium elongatum* Smith, 1876, *Tapinoma fragile* Smith, 1876, *Tapinoma pallipes* Smith, 1876) are excluded. Species in bold are endemic to the island.

Camponotus aurosus Roger, 1863
Camponotus grandidieri Forel, 1886
Crematogaster sewellii Forel, 1891
Dicothryea berlita sp. nov.
Hypoponera johannae (Forel, 1891)
Nesomyrmex gibber Donisthorpe, 1946
Ochetellus vinsoni (Donisthorpe, 1946)
Pheidole picata Forel, 1891
Pheidole tarda Donisthorpe, 1947
Plagiolepis madecassa Forel, 1892
Pristomyrmex bispinosus (Donisthorpe, 1949)
Pristomyrmex browni Wang, 2003
Pristomyrmex trispinosus (Donisthorpe, 1946)
Proceratium avium Brown, 1974
Pseudolasius dodo (Donisthorpe, 1946)
Solenopsis mameti Donisthorpe, 1946
Strumigenys agetos Fisher, 2000
Technomyrmex primrosae Donisthorpe, 1949

Materials and Methods

This work is based on ant inventories in Mauritius from 25 May–31 May, 2005. During that period, we visited Le Pouce Mt., Pieter Both Mt., and Calebasses Mt. in the Moka Range, and Camizard Mt., and Brise Mt. in the Bambous Range. We also collected at Basin Blanc, Ile aux Aigrettes, Cocotte Mt., and Petite Rivière Noire Mt. Ants were collected using general hand search techniques and leaf litter extraction. The work in Madagascar is based on arthropod surveys in Madagascar that included over 6,000 leaf litter samples, 4,000 pitfall traps, and 8,000 additional hand collecting events throughout Madagascar in 1992 through 2004 (Fisher 2005). The species described here was collected as part of an inventory of Réserve Spéciale d'Anjanaharibe-Sud organized by Steve Goodman (Fisher 1998).

All species and type material examined in this study have been imaged and are available on AntWeb (*www.antweb.org*). Material was deposited at California Academy of Sciences, San Francisco (CASC) Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (MCZC), and British Museum of Natural History (BMNH).

Digital images (Fig. 1–17) were created using a JVC KY-F75 digital camera and Syncroscopy Auto-Montage (v 5.0) software. All metric measurements were taken at 80× power with a Leica MZ APO microscope using an orthogonal pair of micrometers and recorded to the nearest 0.001mm and rounded to two decimal places for presentation. The accuracy of the micrometers was tested against a 0.01 mm microscope micrometer before and after measurements. Measurement indices and their abbreviations used in the paper are based on those used by Ward (1988). Size and the shape of the IV abdominal segment are the most important characters for the identification and delimitation of Proceritiinae species.

List of Abbreviations Used

HL Head length: maximum longitudinal length from the anteriormost portion of the projecting clypeus to the midpoint of a line across the back of the head.
HW Head width: maximum width of head, including the eyes, and is taken behind them.
CI Cephalic index: HW/HL x 100.
SL Scape length: maximum chord length excluding basal condyle and neck.
SI Scape index: SL/HW x 100.
WL Weber's length: in lateral view of the mesosoma, diagonal length from posteroventral corner of mesosoma to the farthest point on anterior face of pronotum, excluding the neck.
LS4 Length of abdominal sternum IV as described in Ward (1988).
LT4 Length of abdominal tergum IV as defined in Ward (1988).
IGR Index of gastric reflexion: LS4/LT4

Discothyrea berlita Fisher, sp. nov.

Fig. 1–4.

Type Material.— Holotype: Worker. Mauritius: Le Pouce Mt., Moka Range, 20°11′55″S, 057°31′44″E, 750 m, closed vegetation, 25 May 2005 (coll. B.L. Fisher et al.) Collection code: BLF12148, specimen code: CASENT0007016 (CASC).

Type worker measurements: HL 0.57, HW 0.52, CI 91, SL 0.36, SI 70, LS4 0.08, LT4 0.43, WL 0.64 IGR 0.19.

Diagnosis.— The following character combination differentiates *berlita* from all its congeners: scrobe absent, fused frontal carinae projecting perpendicular to the plane of the clypeus, expanding apically, not forming a thin lamellae; propodeal angle without acute teeth or spines; anterior margin of petiole concave when viewed from above.

Etymology.— The specific name is an arbitrary combination, to be treated as a noun in apposition.

Worker Description.— Form of head, mandibles, and body as shown in Figures 1–4. Antennae 10-segmented; medium segments extremely short and not distinct when viewed with less than 100× magnification; scape expanded apically, reaching mid-point of head. Eyes with 2 or 3 facets. Without depressed scrobal area. Palpal segmentation requires dissection and thus was not determined. Mandible masticatory margin concave, with two teeth, sharp apical tooth and smaller acute basal tooth. Propodeal angle without teeth or acute angles; declivitous face of propodeum concave. Petiole thick, with lateral margins on anterior face; anterior margin concave when viewed from above. Petiole with distinct convex subpetiolar process. Abdominal segment III longer than broad.

Head and mesosoma densely punctulate; petiole sculptured as mesosoma, abdominal segment III with sparse punctures; punctures evanescent on abdominal segment IV. Integument generally opaque, except shiny for impunctate areas of metasoma.

Body, including mandible and appendages, covered with dense fine, very short whitish decumbent pubescence, becoming sparse on abdominal segment III, and dense and nearly erect on abdominal segment IV.

Color testaceous red.

Distribution.— The single specimen was collected in a leaf litter sample in the only remaining patch of dense native vegetation near the summit of Le Pouce. Samples from other nearby mountain tops, Pieter Both (823 m), Calebasses (c.600 m), did not uncover any endemic Proceritiinae.

Comments.— The African species of *Discothyrea* fall into two groups: (1) those with the

FIGURE 1-4. *Discothyrea berlita* worker: holotype CASENT0007016.

clypeo-frontal fusion flat topped and broad and with a depressed scrobe region, and (2) those in which the process forms a simple convex or angular vertical plate and lack a depressed scrobe region (Brown 1958). The *Discothyrea* of Madagascar belong to the first group. *D. berlita* is most similar to those in the second group, but is distinct in that the vertical plate does not form a thin lamella, but is expanded apically (Fig. 3).

Proceratium avium **Brown, 1974**
Figs. 5–13.

Proceratium avium Brown, 1974: 71, figs. 1 and 2 (worker, gyne and male). Mauritius: Le Pouce Mt, 700-800 m, Native forest, 1 Apr. 1969 (coll. W.L. Brown) [examined] AntWeb MCZTYPE32216 (MCZC) [de Andrade 2000:75]

Proceratium avioide de Andrade 2003: 78, figs 37, 38 (worker, gyne and male). Mauritius: Le Pouce Mt, 700-800 m, Native forest, 30 March 1969 (coll. W.L. Brown) [examined] AntWeb MCZTYPE35017 (MCZC). **New synonymy** [see justification below]

During the trip to Le Pouce on May 25 and 30, seven new collections of *Proceratium* from Le Pouce were recorded (Table 2). Because of the small size of the forest patch, only two complete colonies were collected. For the other colonies we encountered, only a few foragers were removed. As Brown (1974) observed, foragers were returning to nests with what appeared to be spider eggs. In this case, they carried the eggs in the mandible, and did not support the eggs with the recurved gaster (Brown 1980). Baroni and de Andrade (2003) suggest the recurved gaster serves a phragmotic function, but I did not observe the recurved gaster being used to plug up the ant nest entrance.

TABLE 2. Collection of *Proceratium avium* on 25 and 30 May 2005 at Le Pouce Mt., Moka Range, 20°11′55″S, 057°31′44″E, 750 m, closed vegetation.

Collection	*Habitat*	*Caste*
BLF12011	foraging on *Nuxia verticillata* with *Pristomyrmex bispinosus*	1 w
BLF12014	foraging on *Nuxia verticillata* with *Pristomyrmex bispinosus*	2 w
BLF12136	ex rot pocket, *Nuxia verticillata*, 1. 5 m above ground	1 erg Q, 127 w
BLF12137	ex rot pocket, *Nuxia verticillata*, 1. 5 m above ground	1 erg. 352w
BLF12139	foraging on *Nuxia verticillata* with *Pristomyrmex bispinosus*	2 w
BLF12140	foraging on *Nuxia verticillata*	8 w
BLF12142	foraging on *Nuxia verticillata*	2 w

Of note is the fact that colony (BLF12137) included 352 workers, one ergatoid queen, and no males. Based on the colony size data reported in Baroni and de Adrade (2003), this is the largest colony size recorded for *Proceratium*. Collections in May by Brown in 1969 included males. All nests encountered were located in *Nuxia verticillata* Lamark (Loganiaceae), with entrances about 1.5–2 m above ground. This tree was also the preferred nesting site for *Pristomyremx bispinosus*. This tree, called bois maigre in Mauritius, has gnarled and twisted trunks. It is endemic to Mauritius and Reunion and appears to be the sole nesting site for *Pristomyremx bispinosus* and *Proceratium avium*. The high winds that are common on Le Pouce abrade the twisted and intertwined trunks and branches. This action damages the tree at the contact point between intersecting branches and leads to the creation of a rot pocket and nesting site.

Three collections of *Proceratium avium* (BLF12011, 12014, and 12139) were foragers following *Pristomyremx bispinosus*. These two species are very similar in color and general appearance. Brown in 1969 also observed this behavior. It is unclear why *Proceratium* is interspersed among the foraging workers of *P. bispinosus*. Conservation of either of these species should include further investigation of potential beneficial interactions between the species.

FIGURES 5–13 Profile, head in full-face view and mesosoma in dorsal view of *Proceratium avium* workers: Figures 5–7: CASENT0059014, BLF12136, collected May 30, 2005; Fig. 8–10: MCZTYPE32216 holotype of *Proceratium avium* collected 1 Apr. 1969; Fig. 11–13: MCZTYPE35017 holotype of *Proceratium avioide* collected 30 March 1969.

JUSTIFICATION OF SYNONYMY.— Brown (1980) collected three series of *Proceratium* at Le Pouce in 1969, one on March 30, and two on April 1. The latter were located less than 500 meters from the March 30 collecting site. He described both of these samples as *Proceratium avium* (Brown 1974). De Andrade (Baroni Urbani and de Andrade 2003) reexamined these three collec-

tions and determined that they represent two species, *P. avioide* and *P. avium*. She based this on the observation that *P. avium* differs from *P. avioide* by the less impressed sculpture, by the denser pilosity, and by longer antennal scapes (*P. avium* SI 87.3-88.6, *P. avioide* SI 81.8–83.3).

The measurements of Brown and de Andrade are not consistent, especially for the *P. avioide* material she examined. Brown noted measurements for the three collections (workers n = 19) as HL 0.92–0.98, HW .091–0.98, CI 96–101 SL 0.90–0.99. Brown did not calculate SI. De Andrade notes that for her *avium*: HL 1.05–1.12, HW .090–0.94, CI 84.5–85.7 SL 0.93–0.97, SI 87.3–88.6 and *P. avioide*, HL 1.10–1.16, HW .092–0.97, CI 82.1–85.1, SL 0.90–0.96, SI 81.8–83.3. Note that CI for Brown ranged from 96–101, while for De Andrade, CI ranged from 82.1–85.7.

One possible reason for these differences is the differences of HW and SL definitions. Based on the definitions presented above, I re-measured the type material using a calibrated micrometer (see Methods above). Measurements are presented in Table 3. These measurements confirm the relative differences between the Brown collections. However, when samples from the seven new collections are included, these differences become less distinct. The seven collections in the study, have even less impressed sculpture than *P. avium*, similar pilosity as *P. avium*, and longer antennal scapes then both *P. avium* and *P. avioide* (SI 98–103). Based on this study of Brown's material and the new collections in this study, I identify all these collections as one species.

TABLE 3. Measurements and scape index of type material and new collections. MCZTYPE32216 is the holotype of *Proceratium avium*, MCZTYPE35017 is the holotype of *Proceratium avioide.*

Specimen number	*HW*	*SL*	*SI*
MCZTYPE35017	0.97	0.92	95
MCZTYPE32216	1.01	0.96	96
CASENT0055844	0.98	1.01	103
CASENT0055842	0.99	1.00	101
CASENT0059012	0.97	0.99	102
CASENT0059013	1.03	1.01	98
CASENT0059026	1.00	1.01	101
CASENT0059030	0.99	1.01	102
CASENT0059029	1.01	1.00	98
min	0.97	0.92	95
max	1.03	1.01	103

The variation observed in these collections is interesting in such a small area. It is possible that because *P. avium* has ergatoid queens, and disperses presumably by budding with low dispersal ability, the complex topography of Le Pouce contributed to the observed variation. The possible restriction of the remaining population to the single forest patch at the base of the southeast peak, however, could severely limit the observed variation in the future.

Proceratium google **Fisher, sp. nov.**
Figs. 14–17.

TYPE MATERIAL.— HOLOTYPE: Worker. MADAGASCAR: Antsiranana, 11.0 km WSW Befingotra, Réserve Spéciale Anjanaharibe-Sud, 14°45′S, 049°27′E, 1565 m, 16 Nov 1994 (coll. B.L. Fisher) sifted litter, montane rainforest, Collection code: BLF1232(6) — CASENT0100367, (CASC) PARATYPES: 2 workers with same data as holotype but with specimen codes CASENT010068 (BMNH), CASENT0100369 (MCZC); 1 worker 9.2 km WSW Befingotra, Réserve Spéciale Anjanaharibe-Sud, 14°45′S, 049°28′E, 1280 m, 5 Nov 1994 (coll. B.L. Fisher), CASENT0100370; (CASC); and 1 worker same as latter but collected at 1200 m on 9 Nov 1994, CASENT0100371 (CASC).

DIAGNOSIS.— The following character combination differentiates *P. google* from all its congeners: abdominal segment IV tergite evenly rounded posteriorly, without concave impression near apex and not hypertrophied; truncate median clypeal lobe; low nodiform petiole without peduncle but with blunt anteroventral tooth; fore tibia with a basal spine, frontal carinae separate and diverging posteriorly; posterior dorsum of mesosoma and propodeal spines granulate-foveolate. *P. google* is easily distinguished from *P. diplopyx*, the only other described *Proceratium* from Madagascar,

FIGURES 14-17. *Proceratium google* worker: holotype CASENT0100348.

TABLE 4. Worker measurements: maximum and minimum based on all five *Proceratium google* specimens.

Specimen CASENT #		*HL*	*HW*	*CI*	*SL*	*SI*	*WL*	*LS4*	*LT4*	*IGR*
0100367	Holotype	1.21	1.02	84	0.80	79	1.34	0.20	0.85	0.23
0100370	Paratype	1.24	1.07	86	0.92	86	1.49	0.18	0.79	0.23
0100371	Paratype	1.24	1.04	84	0.86	83	1.46	0.20	0.77	0.26
0100368	Paratype	1.15	1.03	89	0.84	82	1.36	0.19	0.79	0.23
0100369	Paratype	1.20	1.05	87	0.83	79	1.41	0.17	0.79	0.22
	min	1.15	1.03	84	0.83	79	1.36	0.17	0.77	0.22
	max	1.24	1.05	89	0.86	83	1.46	0.20	0.79	0.26

by the shape of the tergite of the abdominal segment IV. In *P. diplopyx*, the tergite is with a deep concave notch near apex.

ETYMOLOGY.— Named in recognition of the support from the Google company. I hope that Google will continue applying its talent to serve data relevant to the biodiversity community, conservation planners, and the general public. By creating a "Zoogle," Google could help achieve free and democratic access to taxonomic and biodiversity data on species. *P. google* is also suspected to be a specialist egg predator of spiders, which is also why this ant is aptly named after Google— for the ability to hunt down obscure prey. The specific name is an arbitrary combination, to be treated as a noun in apposition.

WORKER DESCRIPTION.— Form of head, mandibles, and body as shown in Figures 14-17. In full-face view, posterior margin of head rounded, not concave; sides of head more or less straight medially; in profile, dorsal margin marginate. Mandible with 4 teeth. Palpal formula 4, 3. Antennae 12-segmented, scape does not reach posterior margin of head. Median clypeal lobe raised and notched medially. Eye a single, large, clear, convex facet that projects beyond the margin of the head in full-face view.

Mesosoma in dorsal view pear-shaped, broader across pronotum than across propodeum. Metanotal grove unmarked. Propodeal spines granulate-tuberculate; declivitous face of propodeum concave, ending basally with an upturned tooth. Petiole longer than wide; subpetiolar process forming an obtuse tooth at midlength. Tibial spur present on each leg. Claws on all legs slender, simple.

Abdominal segment IV tergum evenly rounded posteriorly, without concave impression near apex.

Head, mesosoma, petiole, and abdominal segment III with dense granulate-foveolate sculpture. In contrast, abdominal segment IV predominantly smooth and shiny but with sparse foveae. Declivitous face of propodeum shiny smooth.

Body covered with abundant pilosity consisting of fine, curved, tapered, yellow-white setae.

Queen, male and larvae unknown.

DISTRIBUTION.— Known only from an isolated mountain in Northeastern Madagascar, Réserve Spéciale Anjanaharibe-Sud, 14°45′S, 049°27′E, collected at an elevation of 1565 m. Collections in nearby mountains such as Marojejy did not locate any specimens of this species.

CONSERVATION

Arthropods present several challenges to those dedicated to their conservation. First, they are small and inconspicuous, and thus often forgotten during the conservation planning process. Second, arthropods are overwhelmingly diverse and as a whole, barely known. Is it pragmatic to

develop a conservation strategy for a fauna we scarcely know? Third, because arthropods show a remarkable level of local endemism, they will require strategies and policies that are different from those developed to conserve birds and plants. A case in point is Mauritius.

Conservation in Mauritius is heavily biased to bird and plant preservation (Safford and Jones, 1998; Fowler et al 2000, Nicholas et al. 2004). Land management practices are tailored to benefit plants and birds, but not invertebrates. They are fighting the battle to protect the dwindling patches of native vegetation and bird populations. For plants, this includes the establishments of Conservation Management Areas where alien plants are manually removed (Dulloo et al 2002). In these plots, weedy vegetation is removed up to three times a year. The active removal of large number of weedy plants, however, creates large areas of bare soil and understory (Dulloo et al 2002, pers. obs.). This disturbance facilitates the establishment of invasive ants, at the expense of any remaining native ants (pers. obs.).

The small, one-hectare patch of native forest left on Le Pouce could be destroyed for native ants if an active weeding program is initiated. The closed vegetation is essential for the survival of the endemic *Discothyrea*, *Pristomyremx*, and *Acropya*, which thrive in the cold, moist understory. With weeding and increased insolation and disturbance, the invasive ants that surround this small patch would quickly move in and destroy this ant sanctuary.

An alternative approach to the manual weeding strategy would be to plant native trees around this patch, including *Nuxia verticillata*, which is home to *Proceratium* and *Pristomyrmex*. The goal would be to create a dense closed canopy of natives around this patch without disturbing the patch itself. Over time, the effective size of this patch could expand. We also advise that future collections of endemic ants in Mauritius avoid collecting entire colonies.

Mauritius has shown that once invasive ants take hold, there is almost no way to return the land to native ants and healthy arthropod communities (pers. obs.). Therefore, in Madagascar, land managers must monitor for invasive arthropods. Even though remnant patches of forest may be preserved, invasion by aggressive exotic ants may drive native ants locally extinct. One of the simplest and most effective methods is to track the presence or absence of invasive ants. In this approach, targeted collecting can be performed in habitats and microenvironments most likely to harbor invasives.

Acknowledgments

This work was supported by the National Science Foundation under Grant No. DEB-0344731 to B.L. Fisher and P.S. Ward. Fieldwork that provided the basis for this work could not have been completed without the support of Lorch Lach, Andy Suarez, and Vikash Tatayah from the Mauritian Wildlife Foundation. I am also grateful for the Arthropod Inventory Team (Balsama Rajemison, Jean-Jacques Rafanomezantsoa, Chrislain Ranaivo, Coco Randriambololona, Hanitriniana Rasoazanamavo, Nicole Rasoamanana, Clavier Randrianandrasana, Valerie Rakotomalala, and Dimby Raharinjanahary) who helped collect and process this material. I thank April Nobile for creating the images.

References

Baroni Urbani, C., and M.L. De Andrade. 2003. The ant genus *Proceratium* in the extant and fossil record (Hymenoptera: Formicidae). *Museo Regionale di Scienze Naturali, Monografie* 36: 1–480.

Brown, W.L. 1958. Contributions towards a reclassification of the Formicidae. 2. Tribe Ectatommini. *Bulletin of the Museum of Comparative Zoology at Harvard College.* 118:175–362

Brown, W.L. 1974. A remarkable new island isolate in the ant genus *Proceratium* (Hymenoptera: Formicidae). *Psyche* 81:70–83.

Brown, W.L. 1980. A remarkable new species of *Proceratium*, with dietary and other notes on the genus (Hymenoptera: Formicidae). *Psyche* 86:337–346.

Dulloo, M.E., S.P. Kell, and C.G. Jones. 2002. Conservation of endemic forest species and the threat of invasive species. *International Forestry Review* 4:277–285.

Fisher, B.L. 1998. Ant diversity patterns along an elevational gradient in the Réserve Spéciale d'Anjanaharibe-Sud and on the western Masoala Peninsula, Madagascar. Pages 39–67 in S.M. Goodman, ed., *A Floral and Faunal Inventory of the Réserve Spéciale d'Anjanaharibe-Sud, Madagascar: with Reference to Elevational Variation. Fieldiana: Zoology*, n.s., 90:1–246

Fisher, B.L. 2005. A Model for a Global Inventory of Ants: A Case Study in Madagascar. Pages 78–89 *in* N.G. Jablonski and M.T. Ghiselin, eds., *Biodiversity: A Symposium Held on the Occasion of the 150th Anniversary of the California Academy of Sciences June 17–18, 2003. Proceedings of the California Academy of Sciences*, ser. 4, 56(Suppl. I).

Fowler, S.V., S. Ganeshan, J. Mauremootoo, and Y. Mungroo. 2000. Biological Control of Weeds in Mauritius: Past Successes Revisited and Present Challenges. Pages 43–50 *in* Neal R. Spences, ed., *Proceedings of the Xth International Symposium on Control of the Weeds, 4-14 July 1999.* Montana State University, Bozeman, Montana, USA.

Holway, D.A., L. Lach, A.V. Suarez, N.D. Tsutsui, and T.J. Case. 2002. The causes and consequences of ant invasions. *Annual Review of Ecology and Systematics* 33:181–233.

Lorence, D.H., and R. W. Sussman. 1986. Exotic species invasion into Mauritius wet forest remnants. *Journal of Tropical Ecology* 2:147–162.

Nichols, R., L. Woolaver, and C. Jones. 2004. Continued decline and conservation needs of the endangered Mauritius olive white-eye *Zosterops chloronothos*. *Oryx* 38:291–296.

Safford, R.J. 1997.A survey of the occurrence of native vegetation remnants on Mauritius in 1993. *Biological Conservation* 80:181–188.

Safford, R.J., and C.G. Jones. 1998. Strategies for Land-Bird Conservation on Mauritius. *Conservation Biology* 12:169–176.

Ward, P.S. 1988. Mesic elements in the western Nearctic ant fauna: taxonomic and biological notes on *Amblyopone*, *Proceratium*, and *Smithistruma* (Hymenoptera: Formicidae). *Journal of the Kansas Entomological Society* 61:102–124.

Ward, P.S. 1990. The endangered ants of Mauritius: Doomed like the Dodo? *Notes from the Underground* 4:3–5.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 36, pp. 669–674, 3 figs., 1 table. December 30, 2005

A New Species of Deepwater Snake Eel, *Ophichthus pullus* (Anguilliformes: Ophichthidae), from Angola and Guinea-Bissau

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***Ophichthus pullus*, a new species of snake eel, subfamily Ophichthinae, is described from specimens trawled in deep water (106-154 m) off Angola and Guinea-Bissau. It is most similar to *Ophichthus aphotistos* from Taiwan and *O. cruentifer* from the western Atlantic but differs from them and other elongate, deepwater species of *Ophichthus* in its vertebral number (149-153), snout condition, pectoral-fin shape and size, and dark coloration.**

KEY WORDS: Ophichthidae; *Ophichthus pullus* sp. nov.; Angola, Guinea-Bissau; *Ophichthus aphotistos; Ophichthus cruentifer*; snake eels.

Recent deepwater assessment cruises off the eastern tropical Atlantic by the R/V Dr. Fridtjof Nansen have uncovered a new species of snake eel, genus *Ophichthus*, of the ophichthid subfamily Ophichthinae (*sensu* McCosker 1977). The Nansen specimens were made available to a group of ichthyologists that met at an FAO workshop in Tenerife, Canary Islands, during July 2004. The specimens had been frozen and thawed, and although somewhat tawdry, they were ultimately recognized by the author as an undescribed species. Tomio Iwamoto returned to Angola aboard the Nansen in April 2005 and saved two superb specimens of the new species. In order that the name of that eel become available for the upcoming publication of the FAO *Living Marine Resources of the Eastern Central Atlantic* (Kent Carpenter, editor), I herein describe the new species and compare it to the closely related deep-water ophichthines *Ophichthus aphotistos* and *O. cruentifer*.

Most ophichthids occupy habitats shallower than 100 m, ranging from coral reefs to sand and mud substrates, entering rivers and estuaries. Recent deep-water trapping, trawling, and submersible captures of ophichthids have uncovered a number of new species living at depths as great as 1300 m (McCosker et al. 1989; McCosker 1999; McCosker and Chen 2000). Although most ophichthids are undesirable as a human protein source, they are readily consumed by other fishes and their role in marine ecosystems is poorly understood. It is likely that additional species will be discovered as a result of ongoing deepwater ichthyological surveys.

Materials and Methods

Measurements are straight-line, made either with a 300 mm ruler with 0.5 mm gradations (for total length, trunk length, and tail length), and recorded to the nearest 0.5 mm, or a 1 m ruler with 1 mm gradations and recorded to the nearest 1 mm. All other measurements are made with dial calipers or dividers and recorded to the nearest 0.1 mm. Body length is head plus trunk length.

Head length is measured from the snout tip to the posterodorsal margin of the gill opening; trunk length is taken from the end of the head to mid-anus; maximum body depth does not include the median fins. The jaw rictus of the paratypes were surgically cut on the right side to allow the accurate examination of dentition, a necessary procedure. Head pore terminology follows that of McCosker et al. (1989:257) and McCosker and Chen (2000). Vertebral counts (which include the hypural) were taken from radiographs. The mean vertebral formula (MVF) is expressed as the average of predorsal, preanal, and total vertebrae. Type specimens are deposited at the California Academy of Sciences, San Francisco (CAS). Institutional abbreviations follow the Standard Symbolic Codes for Institutional Research Collections in Herpetology and Ichthyology (Leviton et al. 1985).

Genus *Ophichthus* Ahl, 1789

Ophichthus Ahl, 1789: 5 (type species *Muraena ophis* Linnaeus 1758, by original designation).

Ophichthus pullus McCosker, sp. nov.

(Figs. 1–3; Table 1)

Material examined.— Holotype: CAS 222666, 451 mm TL, a ripe male, from Angola (12°24′S, 13°22′E), 106–107 m, otter trawl, *R/V Dr. Fridtjof Nansen*, Sta. 3608, between 1604–1634 on 1 Aug. 2005. Paratype: CAS 222667, 529 mm TL, a ripening female, from Angola (07°04′S, 12°00′E), 150–154 m, otter trawl, *R/V Dr. Fridtjof Nansen*, Sta. 3767, between 1615–1645, on 20 Aug. 2005. Nonparatype: unnumbered specimen, Centro Oceanográfico de Canarias, Tenerife, 534 mm TL, a ripe male, from Bissau, precise locality and depth unknown.

Diagnosis.— A moderately elongate species of *Ophichthus* with: tail 57–61%, head 8.5–8.9%, and body depth at gill opening 2.8–3.3% of total length; dorsal-fin origin well behind pectoral-fin tips; pectoral fin rounded, not elongate and well-developed; posterior nostril a hole above the upper lip, covered by a flap that extends to or below the edge of the mouth; upper lip lacks barbels between anterior and posterior nostrils; pores small but conspicuous, SO 1 + 4, IO 4 + 2, POM 6 + 2; teeth small and conical, biserial on anterior vomer and jaws; coloration uniform gray-brown to nearly black; total vertebrae 149–153, mean vertebral formula 20.3-56.3-151.3.

Counts and measurements of the holotype (in mm).— Total length 451; head 38.5; trunk 138.5; tail 274; predorsal distance 65; pectoral-fin length 9.6; pectoral-fin base 4.05; body depth *ca.* 12.5 at gill openings; body width *ca.* 12.0 at gill openings; body depth at anus *ca.* 15; body width at anus *ca.* 14.5; snout 6.7; tip of snout to rictus 11.0; eye diameter 3.25; interorbital width 5.4; gill opening height 5.25; isthmus width 6.6. Vertebral formula 18-55-149.

Description.— Body moderately elongate, subcircular to level of anus, then becoming more compressed, its depth at gill openings 30–36 in TL. Branchial basket moderately expanded. Head 3.6–3.8 in trunk. Head and trunk 2.3–2.6 and head 11–12 in TL. Snout rounded, moderately acute when viewed from above; a short groove bisecting underside of snout nearly to tip of upper jaw; snout, lips and chin densely covered with minute sensory papillae. Lower jaw included, its tip reaching beyond anterior base of anterior nostril tube. Upper jaw not elongated, rictus behind a vertical from posterior margin of eye. Eye not enlarged, 3.2–3.6 in upper jaw and 10.1–11.9 in head. Anterior nostrils tubular, extending ventrolaterally from snout at ca. 20°, reaching below upper lip but not reaching tip of chin when directed forward. Posterior nostril a hole above upper lip, covered by a flap that extends below the edge of mouth. There are no barbels along upper lip between the anterior and posterior nostrils. Dorsal-fin origin begins well behind pectoral fin about a head length into trunk length. Median fins low but obvious, ending in a shallow groove a little more than

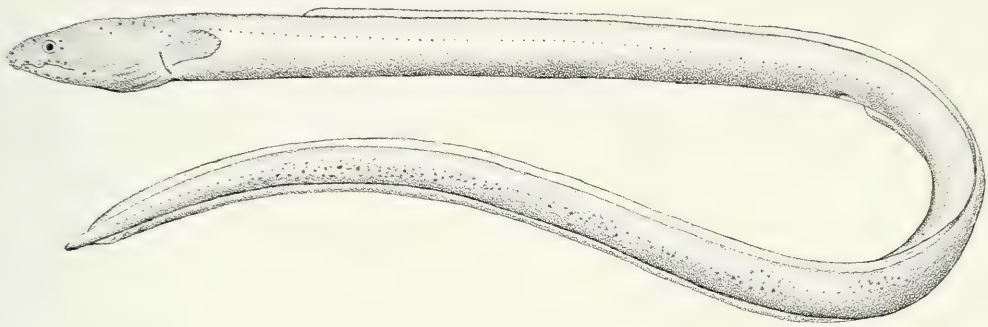

FIGURE 1. Holotype of *Ophichthus pullus* sp. nov., CAS 222666, male, 451mm.

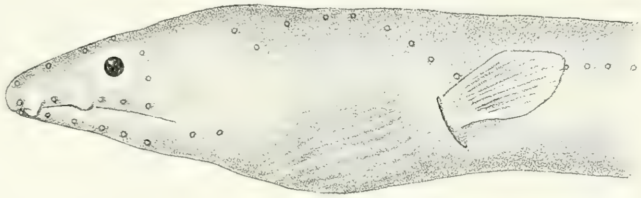

FIGURE 2. Head of holotype of *Ophichthus pullus* sp. nov., CAS 222666, male, 451mm.

2 eye diameters before the bluntly pointed tail tip. Pectoral fins rounded, not elongate and lanceolate.

Head pores identical in position and number for all specimens, small but apparent (Fig. 2). Single median interorbital and temporal pores. Supraorbital pores 1 + 4, infraorbital pores 4 + 2, lower jaw pores 6, preopercular pores 2, supratemporal pores 3. Faint rows of sensory papillae are visible along the nape and beneath and behind the mandible. Lateral-line pores apparent; 8 before gill opening in a high arching sequence, 54–55 before anus, 143–145 total, the last ca. the distance of the snout from the tail tip.

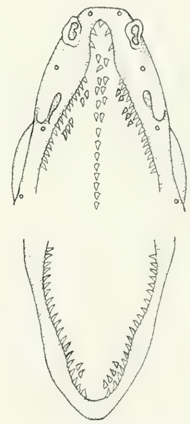

FIGURE 3. Dentition of holotype of *Ophichthus pullus* sp. nov., CAS 222666, male, 451 mm.

Teeth (Fig. 3) small, conical, slightly retrorse. One central and 2 on each side at tip of snout, followed by an intermaxillary rosette of about 5 irregular pairs of teeth, followed by a single row of 8–9 small vomerine teeth, decreasing in size posteriorly. Maxillary with about 6–9 pairs of subequal irregularly biserial teeth, followed by 3–5 uniserial teeth. Lower jaw with about 4–6 pairs of irregularly subequal biserial teeth, followed by 13–18 uniserial teeth.

Color in ethanol uniform gray-brown to black. An irregular pattern of fine black specks equal in size to lateral-line pores along dorsal and ventral surface of trunk and tail. Inner margins of lips pale, with a fine black line extending from beyond eye to rictus. Median fins basally pale. Anterior nostrils, tail tip, anal opening, lateral line and cephalic pores, and margin of median fins pale. Posterior pectoral fin margin pale. Peritoneum pale. Inside of mouth pale, densely speckled with dark brown flecks.

SIZE.— The largest known specimen was 585 mm TL. It was trawled from off Angola, frozen and thawed and in very poor condition and ultimately discarded.

ETYMOLOGY.— From the Latin *pullus*, dark-colored, in reference to its appearance.

DISTRIBUTION.— Known from the type series, from 106–154 m depth, collected from off Angola and Guinea-Bissau.

REMARKS.— The new species appears to be very closely related to the deepwater snake eels

TABLE 1. Counts and proportions (in thousandths) of the holotype, paratype, and nonparatype of *Ophichthus pullus* as compared to three specimens of *O. aphotistos* (from McCosker and Chen 2000) and 10 specimens of *O. cruentifer* (from McCosker et al. 1989). (TL = total length, HL = head length.)

	O. pullus		*O. aphotistos*	*O. cruentifer*
	Mean	Range	Range	Range
TL (mm)	—	451–529	480–628	249–428
HL/TL	88	85–89	77–81	69–87
Head and trunk/TL	415	392–427	396–406	380–430
Tail/TL	585	573–608	594–604	570–620
Depth/TL	30	28–33	25–29	23–30
DFO/TL	175	144–191	123–148	95–160
PF length/HL	237	226–249	208–326	238–306[1]
Upper jaw/HL	317	286–343	311–324	290–370
Snout/HL	183	174–188	204–216	200–230
Eye/HL	92	84–99	94–106	56–92
Predorsal vertebrae	20	18–23	16–19	14–19[2]
Preanal vertebrae	56	55–58	58–60	56–61[3]
Total vertebrae	151	149–153	158–162	144–155[4]

[1] These data reflect the removal of an irregular specimen that was previously included in McCosker and Chen (2000: table 1); [2] n=33; [3] n=31; [4] n=48

Ophichthus aphotistos McCosker and Chen (2000) from Taiwan and *O. cruentifer* (Goode and Bean 1896) of the eastern Atlantic. They are nearly identical in body shape and proportions, physiognomy, pore conditions, and dentition, and are very similar in their dorsal-fin origin, pectoral-fin condition, and coloration. *Ophichthus pullus* differs from *O. aphotistos* and *O. cruentifer* in the length of its lower jaw; when closed, the lower jaw of the new species extends beyond the bases of the anterior nostril tubes, whereas that of the other species either falls short or does not exceed the bases of those tubes. The dentition of the new species is similar in appearance, location, and number to that of *O. cruentifer* (see McCosker et al. 1989: fig. 395), but differs from that of *O. aphotistos* (see McCosker and Chen 2000: fig. 3). Whereas the jaw teeth of *O. pullus* are biserial anteriorly and uniserial posteriorly, those of most *O. aphotistos* are biserial throughout. This however may be related to the size of the specimen in that the smallest paratype (480 mm TL) of *O. aphotistos* also has uniserial maxillary dentition posteriorly (McCosker and Chen 2000: 354–355). *Ophichthus pullus* further differs from *O. aphotistos* (Table 1) in having a shorter head, slightly more posterior dorsal-fin origin, a shorter and blunter snout, a shorter pectoral fin (paddle-shaped rather than lanceolate), and fewer vertebrae. *Ophichthus pullus* further differs from *O. cruentifer* (Table 1) in having a longer head, a slightly more posterior dorsal-fin origin, a generally smaller eye, a shorter and blunter snout, a shorter and broader pectoral fin, and a darker coloration (uniform tan to grayish brown, rather than dark gray to black). *Ophichthus pullus* attains a larger size than does *O. cruentifer*; the known specimens of *O. pullus* range from 451–585 mm TL, whereas the largest of 84 specimens of *O. cruentifer* examined by Wenner (1976) was 423 mm TL and the largest of 80 specimens examined by McCosker et al. (1989) was 467 mm TL. *Ophichthus cruentifer* occupies depths similar to that occupied by the new species, and *O. aphotistos* has been captured by trawl over sand and muddy substrates between 36–1350 m (McCosker et al. 1989), and was observed from submersibles by Wenner (1976) to be most abundant between 250–350 m, with only their heads exposed over sandy substrates or resting on the sediment with their bodies in S-shaped curves.

The new species was also compared to specimens and descriptions of other elongate Indo-Pacific species of *Ophichthus*. The deepwater (235–490 m) western Indian Ocean *O. serpentinus*

Seale (1917) is similar in elongation and appearance, but has more vertebrae (163–167) and uniserial mandibular teeth. *Ophichthus pullus* is also similar in appearance to *Ophichthus exourus* McCosker (1999), a deepwater (450–520 m) species from New Caledonia and Fiji, which differs in having uniserial mandibular teeth and more vertebrae (176–177). *Ophichthus brachynotopterus* Karrer (1982), known from three deepwater (355–428 m) specimens from NE Madagascar, has similar but more irregular biserial dentition, a much larger eye, a more posterior dorsal-fin origin (above the 27th–31st vertebrae), and more vertebrae (178).

Various subgeneric lineages can be identified within *Ophichthus* (sensu lato), and a comprehensive examination of the more than 55 valid species may result in the elevation of several subgenera to generic status (McCosker 1977; McCosker et al. 1989). Based on current knowledge, the new species and its relatives *O. aphotistos* and *O. cruentifer* would reside in *Omochelys* (Fowler 1918, originally described as a subgenus of *Pisodonophis*), type species *Pisodonophis cruentifer* Goode and Bean (1896).

Comparative material examined.— *Ophichthus aphotistos*, CAS 209192, 580 mm TL (holotype), and USNM 356862, 628 mm TL, and NSYSU 3657, 480 mm (paratypes). *Ophichthus brachynotopterus*, MNHN 1979-22, 442 mm TL, and 413 mm TL (MNHN 1979-23, 413 mm TL (paratypes). *Ophichthus cruentifer*, USNM 28938, 415 mm TL (lectotype), and 80 additional specimens 67–467 mm, as listed in McCosker et al. (1989: 386). *Ophichthus exourus*, MNHN 1995-425, 520 mm (holotype), and CAS 89552, 429 mm (paratype). *Ophichthus serpentinus*, MCZ 9200, 495 mm, holotype.

Acknowledgments

I wish to thank Tomio Iwamoto for collecting the type specimens; Kent Carpenter, Michel Lamboeuf, and Pere Oliver for inviting my participation in the FAO workshop; Eduardo Balguerías Guerra for assistance during the FAO workshop; Beth Herd Guy for preparing the illustrations; the late Eugenie Böhlke (Academy of Natural Sciences, Philadelphia [ANSP]), and the staffs of the California Academy of Sciences (CAS), Museum of Comparative Zoology, Harvard University (MCZ), Muséum National d'Histoire Naturelle, Paris (MNHN), and the National Museum of Natural History (NMNH), Washington D.C., for advice and assistance with specimens; Alan Leviton for his patience and assistance; Tomio Iwamoto for reading a draft of this manuscript; and the volume editors, who caught a few unpardonable goofs in the typescript.

Literature Cited

Ahl, J.N. 1789. Dissertatio de Muraena et Ophichtho. *Dissertationes Academicae Upsaliae habitae sub praesidio C.P. Thunberg* 3(1):1–12.

Fowler, H.W. 1918. New and little known fishes from the Philippine Islands. *Proceedings of the Academy of Natural Sciences of Philadelphia* 70:2–71.

Goode, G.B., and T. H. Bean. 1896. *Oceanic Ichthyology, a Treatise on the Deep-Sea and Pelagic Fishes of the World* . . . with an Atlas containing 417 figures. Special Bulletin of the U.S. National History Museum Vol. 1. 553 pp.

Karrer, C. 1982. Anguilliformes du Canal de Mozambique (Pisces, Teleostei). *Faune Tropicale* 23:1–116.

Leviton, A.E., R.H. Gibbs, Jr., E. Heal, and C.E. Dawson. 1985. Standards in Herpetology and Ichthyology: Part I. Standard symbolic codes for institutional resources collections in Herpetology and Ichthyology. *Copeia* 1985:802–832.

McCosker, J.E. 1977. The osteology, classification, and relationships of the eel family Ophichthidae. *Proceedings of the California Academy of Sciences* ser. 4, 41(1):1–123.

McCosker, J.E. 1999. Pisces Anguilliformes: Deepwater snake eels (Ophichthidae) from the New Caledonia region, Southwest Pacific Ocean. Pages 571–588 *in* A. Crosnier, ed., Résultats des Campagnes MUSORSTOM Vol. 20. *Mémoires du Muséum national d'Histoire naturelle* 180.

McCosker, J.E., E.B. Böhlke, and J.E. Böhlke. 1989. Family Ophichthidae. Pages 254–412 in *Fishes of the Western North Atlantic*, Part 9, Vol. 1: *Orders Anguilliformes and Saccopharyngiformes*. Sears Foundation for Marine Research, Yale University, New Haven. Connecticut, USA.

McCosker, J.E., and Y. Chen. 2000. A new species of deepwater snake-eel, *Ophichthus aphotistos*, with comments on *Neenchelys retropinna* (Anguilliformes: Ophichthidae) from Taiwan. *Ichthyological Research* 47(4):353–357.

Seale, A. 1917. New species of apodal fishes. *Bulletin of the Museum of Comparative Zoology, Harvard College* 61(4):79–94.

Wenner, C.A. 1976. Aspects of the biology and morphology of the snake eel, *Pisodonophis cruentifer* (Pisces, Ophichthidae). *Journal of the Fisheries Research Board of Canada* 33(4):656–665.

PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES
Fourth Series

Volume 56, No. 37, pp. 675–683, 3 figs. December 30, 2005

Two New Species of Melastomataceae from Southern Mesoamerica

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Two new species of Melastomataceae, *Blakea venusta* (Blakeeae), endemic to Costa Rica, and *Miconia dissitinervia* (Miconieae), restricted to Costa Rica and Panama are described and illustrated. *Blakea venusta* is distinguished by its epiphytic, pendent habit, copious indument of spreading reddish-brown hairs, and paired leaves at a node that are commonly dimorphic in size. *Miconia dissitinervia* is characterized by a calyx that is fused in bud but ruptures at anthesis into irregular hyaline lobes. Distributional and phenological notes are provided together with diagnostic illustrations, photographs taken in the field, and keys to separate these species from their presumed closest relatives.

Resumen

Dos nuevas especies de Melastomataceae, *Blakea venusta* (Blakeeae), endémica de Costa Rica, y *Miconia dissitinervia* (Miconieae) restringida a Costa Rica y Panamá son descritas e ilustradas. *Blakea venusta* muestra un carácter vegetativo poco común en el género, sus hojas fuertemente dimórficas en tamaño por nudo; *Miconia dissitinervia* por otro lado, presenta un carácter del andróceo que comparte con pocos congéneres, su caliz fusionado en botón y que se rompe en antésis en lóbulos irregulares hialinos. También se incluyen notas sobre distribución y fenología, así como fotografías y claves para separar las especies de sus parientes más cercanos.

Two new species of berry-fruited Melastomataceae, *Blakea venusta* and *Miconia dissitinervia,* are described from Costa Rica and Panamá in the Mesoamerican biodiversity hotspot (Mittermeier et al., 1999; Mittermeier et al. 2004). Description of a new *Blakea* now brings the number of Mesoamerican species in that genus to 34, over 75% of which are restricted to Costa Rica and Panamá (Almeda 2000a). Addition of another species of *Miconia* brings the total number of species in that genus for the Mesoamerican region to 163, 127 of which are also known only from Costa Rica and Panamá. Almeda (2000a, 2000b) commented on the importance of this southern Mesoamerican area as a secondary center of diversity for both of these genera and predicted that additional taxa would come to light as remote areas were explored. Discovery of the two species described here suggests that continued exploration of readily accessible collecting sites throughout the year will continue to yield new and noteworthy taxa.

Blakea venusta **Kriebel, Almeda & Estrada, sp. nov.**
Figs. 1, 2D.

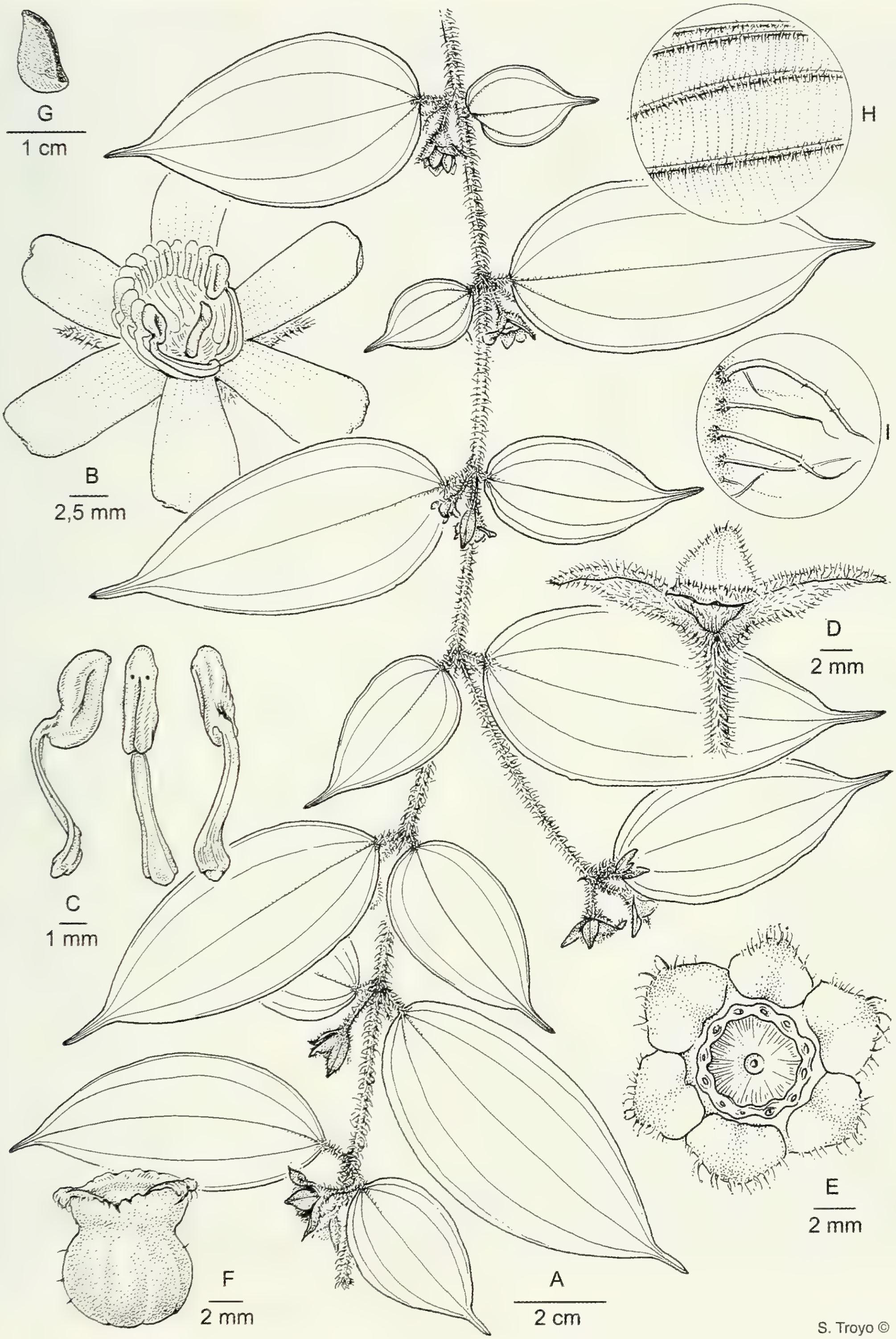
Type.— Costa Rica: **San José**: Pérez Zeledón, Cordillera de Talamanca, Carretera Interamericana km 115-116, bosque primario y secundario a la par del camino entre División y Hortensia, 9°28′40″, 83°41′25″, 1750 m, 12 Nov. 2003 (fl, fr), *R. Kriebel & D. Solano 4081* (Holotype: INB!; Isotypes: CAS!, CR!, MO!).

Frutex epiphyticus. Ramuli sicut petioli, folia subtus pedunculi setosi 1—3.5 mm longis induti. Folia in quoque pari dimorpha chartacea integra apice caudato-acuminata basi obtusa vel rotundata. Folia maiora: lamina 5–9.9 × 2.6–5.2 cm lanceolato-ovata, elliptica vel elliptico-ovata, 5-nervata. Folia minora: lamina 1–4 × 1–2.4 cm, ovata vel suborbiculata, 3-nervata. Flores 6-meri in quoque nodo 1–3; pedunculi 3–12 mm longis; bracteae omnino liberae; bracteae exteriores 7–15 × 2.5–4.5 mm, lanceolatae vel elliptico-lanceolatae; bracteae interiores 5–11 × 4–6 mm, ovato-lanceolatae. Calycis tubus 1–1.5 mm longus, lobis 1.5–2.5 × 3.5–4.5 mm. Petala 13–17 × 5–7 mm oblonga. Antherarum thecae 4 × 2 mm oblongae inter se cohaerentes apice minute biporosae; connectivum nec prolongatum nec appendiculatum. Ovarium 6-loculare, omnino inferum, apice papilloso.

Epiphytic shrub with sprawling, subscandent or pendent branchlets. Young vegetative buds, internodes, petioles, abaxial foliar surfaces, floral peduncles and bracts densely setose with simple, basally barbed reddish-brown hairs, 1–3.5 mm long. Leaves at a node slightly unequal to generally very unequal in length, somewhat dimorphic to isomorphic in shape, chartaceous, sparsely villose to glabrous adaxially, apex caudate-acuminate, base obtuse to rounded, margin entire. Large leaves at a node: blade 5–9.9 × 2.6–5.2 cm, lanceolate-ovate, elliptic, elliptic-ovate or elliptic-oblong, 5-nerved; petioles 2–7 mm long. Small leaves a node: blade 1–4 × 1–2.4 cm, broadly lanceolate, ovate or suborbicular, 3-nerved; petioles 0.5–5 mm. Flowers spreading but not pendent, frequently hidden under subtending leaves, 1–3 flowers in each leaf axil; peduncles 3–12 mm long. Floral bracts foliaceous, all free from one another, typically longer than the hypanthium proper in length, adaxially moderately covered with spreading basally barbed hairs, margin entire; outer bracts 7–15 × 2.5–4.5 mm, lanceolate to elliptic-lanceolate, apex acuminate, with a somewhat conspicuous midvein; inner bracts 5–11 × 4–6 mm, ovate-lanceolate, apex acute. Calyx tube 1–1.5 mm long; free portions of the calyx lobes 1.5–2.5 mm long and 3.5–4.5 mm wide, broadly deltoid to rounded-deltoid, with each lobe terminating in a blunt reflexed callose thickening, margin entire and beset with gland-tipped hairs, the adaxial surface papillose and strigillose with barbellate hairs especially towards the apex, abaxial surface sparsely papillose and strigillose with roughened hairs grading into stellate hairs basally. Petals 6, 13–17 × 5–7 mm, white, oblong, obliquely rounded apically, entire and sparsely beset with gland-tipped hairs. Stamens 12; staminal filaments 6.5–8.5 mm long, declined to one side of the flower opposing the style, white, inconspicuosly flushed with pink basally; anthers 4 x 2 mm, yellow, laterally connate for practically their entire length, oblong and somewhat arcuate in dorsal view, laterally compressed, the two pores positioned 0.5–0.75 mm below the apex of the anther on the ventral face, connective simple. Ovary 6-locular, papillose and truncate apically. Style erect and somewhat incurved distally, 8.5–9.5 mm long, glabrous, distal half white and basal half pink; stigma punctiform. Berry globose, 8–10 × 6–8 mm, moderately to sparingly stellulate-furfuraceous. Seeds mostly 1 mm long, beige, narrowly pyriform.

Distribution and Phenology.— A local species presently known only from Costa Rica where it occurs in cloud forests at 1300–1750 m on the Pacific slope of the Cordillera de

Figure 1 (right). *Blakea venusta* Kriebel, Almeda & Estrada. A. habit; B. fully expanded flower; C. representative stamens; D. hypanthium with subtending floral bracts, (one inner bract, petals, style, and stamens removed); E. top view of young fruit showing stylar scar, toral ring, and calyx lobes; F. berry; G. representative seed; H. enlargement of primary foliar veins (abaxial surface); I. enlargement of indument on cauline internodes. (A-I from *Kriebel & Solano 4081*.)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S. Troyo ©

Talamanca. *Blakea venusta* is common to abundant at both of its known localities and grows sympatrically with other rare species of Melastomataceae such as *Clidemia davidsei* Almeda, *Blakea wilsoniorum* Almeda, *Henriettella trachyphylla* Triana, *Miconia cremadena* Gleason and *M. costaricensis* Cogn. Collected in flower and fruit in September and November; also with fruits in June.

Paratypes.— Costa Rica: **San José**: Pérez Zeledón, Cordillera de Talamanca, Carretera Interamericana, km 115–116, bosque primario y secundario a la par del camino entre División y Hortensia, 9°28′40″, 83°41′25″, 1750 m, 3 June 2003 (fr), *Kriebel & Hammel 3340* (CAS, CR, INB, MO); Pérez Zeledón, Cordillera de Talamanca, P.N. Chirripó, Estación Santa Elena, colectado a orilla de río y potrero, 9°23′36″, 83°35′21″, 1300–1400 m, 17 Sep. 1997 (fl, fr), *Alfaro 1420* (CR, INB, MO).

Blakea venusta is readily recognized by its dense setose indument of simple, basally barbed reddish-brown hairs 1–3.5 mm long on young vegetative buds, internodes, petioles, abaxial foliar surface, floral peduncles and bracts, leaves that are strongly dimorphic in size at each node, short pedunculate flowers, calyx lobes and petals marginally beset with gland-tipped hairs, and anthers laterally connate for practically their entire length. In the most recent key to species of *Blakea* in Mexico and Central America (Almeda, 2000a), *B. venusta* keys to couplet 12 next to *B. guatemalensis* and *B. foliacea*, clearly its presumed closest relatives on the basis of foliar dimorphism, inner and outer floral bracts that are free to the base, and laterally connate anthers. The three species can be distingushed by the following key:

1. Uppermost internodes, young vegetative buds, and floral peduncles densely to moderately covered with a scurfy paleaceous indument intermixed with or sometimes replaced by ± flattened, roughened hairs or varying to nearly glabrous with age; leaf blades either subpeltate or bearing domatia; peduncles 1.2–5.7 cm; calyx lobe and petal margin lacking glandular hairs; connective dorsally appendaged
   2. Leaf blades subpeltate at the base, lacking inconspicuous domatia in the angles between the median vein and each of the two innermost veins on the abaxial surface . . . . *B. guatemalensis* Donn. Sm.
   2'. Leaf blades not subpeltate at the base, inconspicuous domatia (these often ruptured) typically formed in the angles between the median vein and each of the two innermost veins on the abaxial surface . . . . *B. foliacea* Gleason

1'. Uppermost internodes, young vegetative buds, and floral peduncles densely covered with simple, basally barbed reddish-brown hairs 1–3.5 mm long; leaf blades neither subpeltate nor bearing domatia; peduncles 0.3–1.2 cm; calyx lobe and petal margin sparsely beset with glandular hairs; connective unappendaged . . . . *B. venusta* Kriebel, Almeda & Estrada

***Miconia dissitinervia* Kriebel, Almeda & Estrada, sp. nov.**
Figs. 2A–C, 3.

Type.— Costa Rica: **San José**: Turrubares, San Juan de Mata. Area no protegida. Lajas. 9°42′20″N 84°35′13″W, elev. 600 m, 26 Nov. 1983, *A. Estrada et. al. 3101* (Holotype: CR!; Isotypes: CAS!, INB!, MO!).

Section *Amblyarrhena.* Frutex vel arbuscula 1–5 m altus. Ramuli obscure quadrangulati sicut petioli folia subtus inflorescentia hypanthiaque dense stellatis induti. Petioli 1.5–2.5 cm longi; lam-

Figure 2 (right). *Miconia dissitinervia* Kriebel, Almeda & Estrada. A. habit showing inflorescence; B. close-up of fully expanded flower showing reflexed petals; C. representative leaf showing abaxial surface; D. *Blakea venusta* Kriebel, Almeda & Estrada, fully expanded flower showing declinate semicircle of connate anthers. (A–C from live material of *Kriebel et al. 5046*; D from live material of *Kriebel & Solano 4081*.)

A B C D

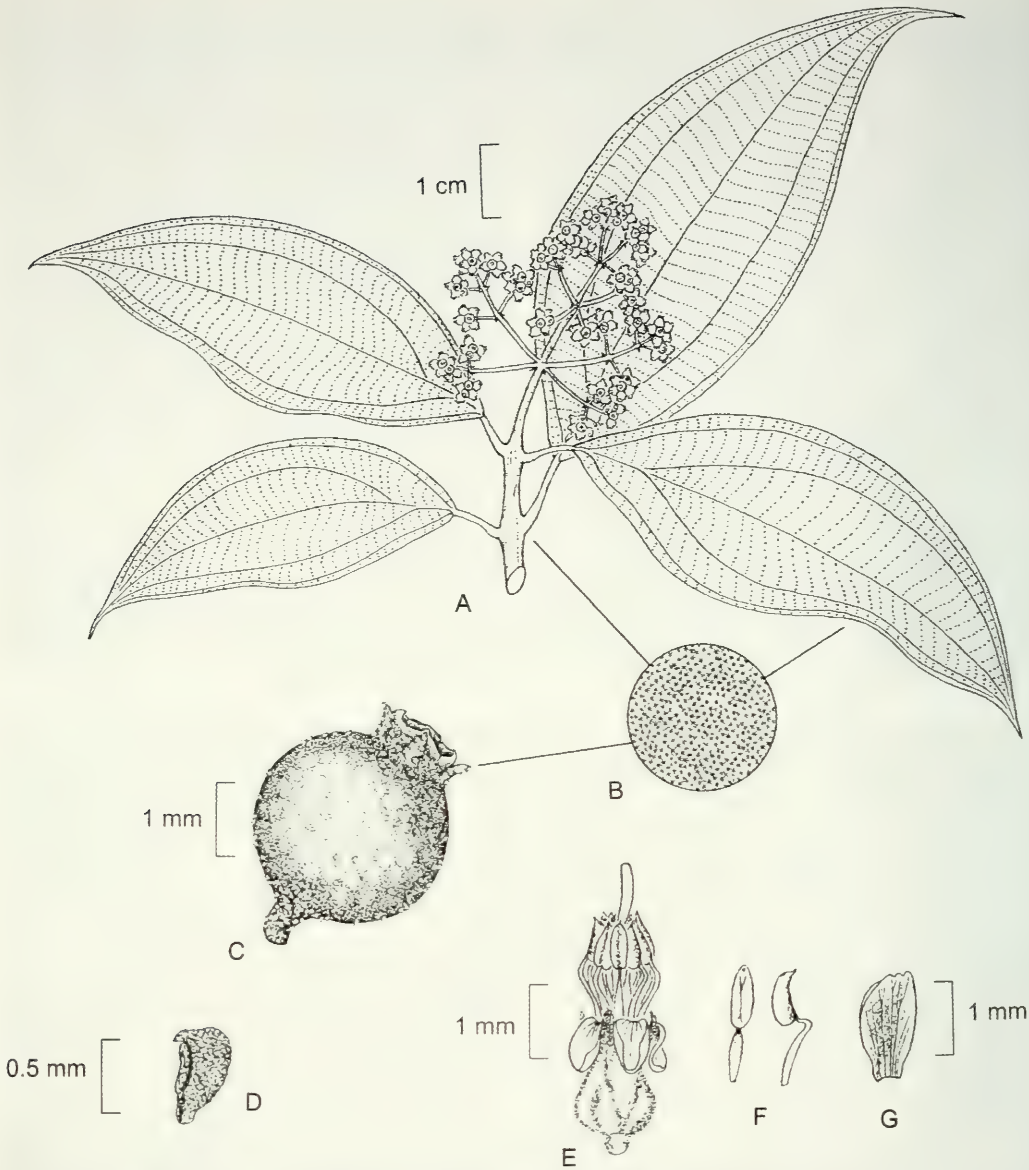

FIGURE 3. *Miconia dissitinervia* Kriebel, Almeda & Estrada. A. habit with infructescence; B. enlargement of stellate indument on foliar and hypanthial surfaces; C. berry; D. representative seed; E. fully expanded flower; F. stamens, ventral view (left) and profile view (right); G. representative petal, adaxial surface. (A–G from *Aguilar 4977*.)

ina 10–35 × 5–15 cm elliptica vel elliptico-ovata, 3–5-plinervata. Panicula 8–10 cm longa multiflora; flores 5-meri, pedicellis (ad anthesim) 0.25–0.5 mm longis, bracteolis 1 mm longis. Hypanthium (ad torum) 2 mm longum; calyx primum in cono apiculato clausus demum in lobos irregulares persistentes ruptus, dentibus exterioribus 0.15–0.25 mm eminentibus. Petala ca. 2 × 1 mm oblonga papillosa. Stamina isomorphica glabra; filamenta 1.5 mm longa; antherarum thecae 1 × 0.4 mm angustae oblongae, poro ventraliter inclinato; connectivum nec prolongatum nec appendiculatum. Stylus 3–4 mm glaber; ovarium 5-loculare et omnino apice glabro.

Shrub to small tree 1–5 m tall; uppermost branchlets, vegetative buds, petioles, lower leaf-surfaces, inflorescences, bracts, bracteoles, and hypanthia completely covered with an indument of stellate hairs. Leaves of a pair equal to unequal in size; petioles 1.5–2.5 cm long; leaf-blades 10–35 × 5–15 cm, chartaceous, elliptic (sometimes broadly so) to elliptic-ovate, margin entire to inconspicuously crenulate, apex acuminate to long-acuminate, base acute to long-attenuate, 3–5-plinerved (excluding the ill-defined inframarginal pair) with the inner pair of primary subparallel veins diverging from the median vein in alternate or subalternate fashion. Inflorescence a terminal multiflowered panicle 8–10 cm long; bracts and bracteoles linear, 1–2 × 0.25–0.5 mm, caducous; pedicels 0.25–0.5 mm long. Hypanthia (at anthesis) urceolate, 2 mm long to the torus; calyx tube 0.25 mm long; calyx fused in bud but rupturing irregularly at anthesis into 2–5 persistent hyaline lobes; calyx teeth 0.15–0.25 mm long, narrowly triangular. Petals 5, ca. 2 × 1 mm, papillose adaxially, white, oblong, rounded to emarginate apically, conspicuously reflexed at anthesis. Stamens 10, isomorphic; filaments glabrous, complanate, 1.5 mm long; anthers 1 × 0.4 mm, yellow, linear-oblong, apiculate at the apex, laterally compressed and deeply ventrally channeled between the thecae ventrally, 2-celled, the single pore ventrally inclined; connective simple, neither prolonged nor appendaged. Ovary 5-locular, completely inferior, globose, the apex somewhat depressed. Style 3–4 mm long, erect, glabrous; stigma punctiform. Berry globose, purple at maturity, 4–5 mm in diameter; seeds 0.5 mm long, pyramidate, the testa muriculate to papillate.

Distribution and Phenology.— Known only from the Pacific slope of Costa Rica, from Turrubares to the Península de Osa south to Panamá, where it has been collected at Puerto Armuelles on the Burica Peninsula from sea level to 600 m. Collected in flower between November and January and in fruit between November and June.

Paratypes.— Costa Rica: Puntarenas: Puerto Jiménez, Agujas, 08°33′N 83°23′W, 23 Jan. 1995, *Aguilar & Azofeifa 3710* (CAS, CR, INB, MO); Parque Nacional Corcovado, Estación Sirena, Sendero Ollas, 08°28′N 83°35′W, 9 Feb. 1994, *Aguilar 3103* (CAS, CR, INB, MO); Parque Nacional Corcovado, Estación Sirena, Sendero Espaveles, 08°28′N 83°35′W, 16 Jan. 1997, *Aguilar 4977* (CR, INB, MO); west of Rincón de Osa, Península de Osa, 9–12 Jan. 1970, *Burger & Liesner 7253* (CR); along abandoned "high road" W of Rincón de Osa, 8°42′N 83°31′W, 4 Mar. 1985, *Croat & Grayum 59849* (CAS, CR, MO); fila before Rancho Quemado, near Rincón, 08°42′N 83°33′W, 11 Jan. 1993, *Gentry et. al. 78687* (CAS, INB, MO); cerca del rio Piro, Peninsula de Osa, 29 Dec. 2004, *Kriebel et al. 5046* (CAS, CR, INB, MO); Aguabuena, 3 km W of Rincón, 800 m N of house of Henry Monge, 4 June 1993, *Thomsen 361* (CR). PANAMA. Chiriquí: Burica Península, San Bartolo Limite, 12 miles west of Puerto Armuelles, 24 Feb. 1973, *Liesner 201* (CAS, CR).

Discussion.— *Miconia dissitinervia* shares a number of diagnostic characters with *M. centrosperma* of Panamá. Both species have plinerved leaves, blunt calyx teeth, a completely inferior 5-locular ovary, unappendaged anther connectives and a punctiform stigma. They are easily separated by the characters enumerated in the key below. *Miconia dissitinervia* has been misidentified in the past as *Miconia argentea* (Sw.) DC. probably because of the shared stellate indument on abaxial foliar surfaces. *Miconia dissitinervia* differs from the latter in having plinerved vs. nerved foliar venation, a punctiform stigma vs. clavate-crateriform stigma, unappendaged anthers vs. appendaged anthers, an irregularly rupturing hyaline calyx vs. nonrupturing regularly developed calyx lobes, and seeds with a muriculate or papillate testa vs. an angulate, smooth testa.

Key to the Mesoamerican species of *Miconia* with a fused calyx that ruptures at anthesis.

1 Flowers 4-merous

2. Distal branches, petioles, and inflorescence densely covered with a mixture of rusty brown sessile-stellate and stipitate-stellate hairs; flowers with pedicels to 0.5 mm; anther pore somewhat ventrally inclined; connective neither prolonged nor appendaged . . . . *M. calocoma* Almeda

2′ Distal branches, petioles and inflorescence sparingly and deciduously covered with stellulate hairs and/or minute glands or uppermost internodes and adaxial petiolar surface sparsely covered with smooth hairs and minute and appressed glandular hairs; flowers sessile or essentially so; anther pore dorsally inclined; connective appendaged dorso-basally

3 Leaves 5-nerved; stigma not expanded; ovary (2)–3-locular . . . . *M. valeriana* (Standl.) Wurdack

3′ Leaves 5-plinerved; stigma capitate; ovary 4-locular . . . . *M. centrodesma* Naudin

1′ Flowers 5(–6)-merous

4 Abaxial leaf surface completely covered with an indumenta of stellate or stellate-lepidote hairs resulting in a white to reddish-white color

5 Leaf blades 7.5–12 × 2.4–4 cm, 3-plinerved, stellate-lepidote abaxially; inflorescences 2–2.5 cm long; petals glabrous; ovary apex densely setose around the stylar scar; seeds with a conspicuous spur at the wider truncate end . . . . *M. centrosperma* Almeda

5′ Leaf blades 10–35 cm × 5–15 cm, 5-plinerved, stellate abaxially; inflorescences 8–10 cm long; petals papillose adaxially; ovary apex glabrous; seeds lacking a conspicuous spur on the truncate distal end . . . . *M. dissitinervia* Kriebel, Almeda & Estrada

4′ Abaxial leaf surface variously pubescent but never completely covered with a conspicuous white or reddish-white indument

6 Abaxial leaf surface minutely and deciduously glandular-puncticulate to glabrous on the actual surface and copiously beset with tufts of stalked-stellate hairs where the innermost primary veins diverge from the median vein; ovary 3-locular . . . . *M. mexicana* (Bonpl.) Naudin

6′ Abaxial leaf surface variously pubescent but never beset with tufts of stalked-stellate hairs only where the innermost primary veins diverge from the median vein; ovary (4) 5-locular

7 Leaf blades 5–7-plinerved; flowers on pedicels 0.5–2.5 mm

8 Leaves subsessile and clasping or sometimes with petioles 1–5(–9) mm long; stamens dimorphic, the larger ones antepetalous . . . . *M. dissitiflora* Almeda

8′ Leaves with petioles 1.5–9 cm long; stamens isomorphic

9 Young cauline internodes, petioles, and hypanthia densely covered with inconspicuously stalked asperous-headed hairs; inflorescence erect and branched basally at the node from which it is initiated; mature leaf blades 5-plinerved. . . . . *M. friedmaniorum* Almeda & Umaña

9′ Young cauline internodes, petioles, and hypanthia densely covered with a lanate indument of curly or sinuate barbed or distally bifid hairs that are intermixed with and grade into a ground layer of shorter amorpho-pinoid hairs; inflorescence arcuate or pendent and branched well above the node from which it is initiated; mature leaf blades 7-plinerved . . . . *M. pendula* Umaña & Almeda

7′ Leaf blades 3–5-nerved; flowers sessile or essentially so

10 Branchlets, petioles, elevated primary leaf veins beneath, and inflorescences densely covered with stalked-stellate hairs; bracteoles oblong . . . . *M. dorsiloba* Gleason

10′ Branchlets, vegetative buds, inflorescences, and hypanthia sparsely and deciduously stellulate-furfuraceous or uppermost internodes, adaxial surfaces of the petioles and leaf blades sparsely covered with smooth hairs (gland-tipped in part) 0.5–2.5 mm long underlain with minute glandular hairs; bracteoles setiform or subulate-setose

11 Leaf blades 6–20 × 3–8.9 cm, 5-nerved, adaxially sparsely covered with smooth hairs (gland-tipped in part) 0.5–2.5 mm underlain with minute glandular hairs; petals glabrous; stigma capitate . . . . *M. valeriana* (Standl.) Wurdack

11′ Leaf blades 12–39 × 6.5–20.5 cm, 3-nerved, glabrous; petals densely granulose-papillose; stigma barely expanded. . *M. lamprophylla* Triana

Acknowledgments

We are grateful to Silvia Troyo (Fig. 1) and Claudia Aragon (Fig. 3) for the illustrations and Alan Chou and Dominique Jackson for technical assistance. The first author thanks Daniel Solano, Daniel Santamaria, Barry Hammel and Reinaldo Aguilar for companionship on field trips that resulted in some collections of the new taxa treated here. Two anonymous reviewers also offered most useful comments. The photographs in Figure 2 were taken by Ricardo Kriebel.

Literature Cited

Almeda, F. 2000a. A synopsis of the genus *Blakea* (Melastomataceae) in Mexico and Central America. *Novon* 10:299–319.

Almeda, F. 2000b. New Costa Rican and Panamanian Species of *Miconia* (Melastomataceae: Miconieae). *Proceedings of the California Academy of Sciences,* ser. 4, 52(4):33–54.

Mittermeir, R. A., N. Myers, and C.G. Mittermeier. 1999. H*otspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions.* CEMEX/ Agrupación Sierra Madre, Mexico City, Mexico. 432 pp.

Mittermeier, R.A., P.R. Gil, M. Hoffmann, J. Pilgrim, T. Brooks, C.G. Mittermeier, J. Lamoreux, and G.A.B. Fonseca. 2004. *Hotspots Revisited.* CEMEX/ Agrupación Sierra Madre, Mexico City, Mexico. 390 pp.

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Indexes to Volume 56 and to Supplements I and II

(Compiled by Michele L. Aldrich and Alan E. Leviton).

Index to Volume 56 for 2005

Articles 1 through 37 and Short Communications

B

C

D

Diatoms

(Excludes diatoms in checklist, pp. 400–480)

J

K

L

M

Q

R

S

T

U

V

W

Y

Z

Index to Volume 56, Supplement I

Biodiversity: Past Present, and Future, and The Future of Taxonomy
edited by Nina G. Jablonski and Michael T. Ghiselin

F

G

H

I

J

L

M

T

U

V

W

Index to Volume 56, Supplement II

Atlas of Phylogenetic Data for Entelegyne Spiders (Araneae: Araneomorphae: Entelegynae) with Comments on their Phylogeny

by C.E. Griswold, M.J. Ramíez, J.A. Coddington, and N.I. Platnick

A

H

I

K

L

M

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TABLE OF CONTENTS